

SYSTEMS DESIGN

JANUARY-FEBRUARY 1961

featuring:

Timing Techniques

*Design of Vacuum-Deposited
Circuitry*

*High Speed Reliability in
Automatic Testing*

Electronic Circuitry

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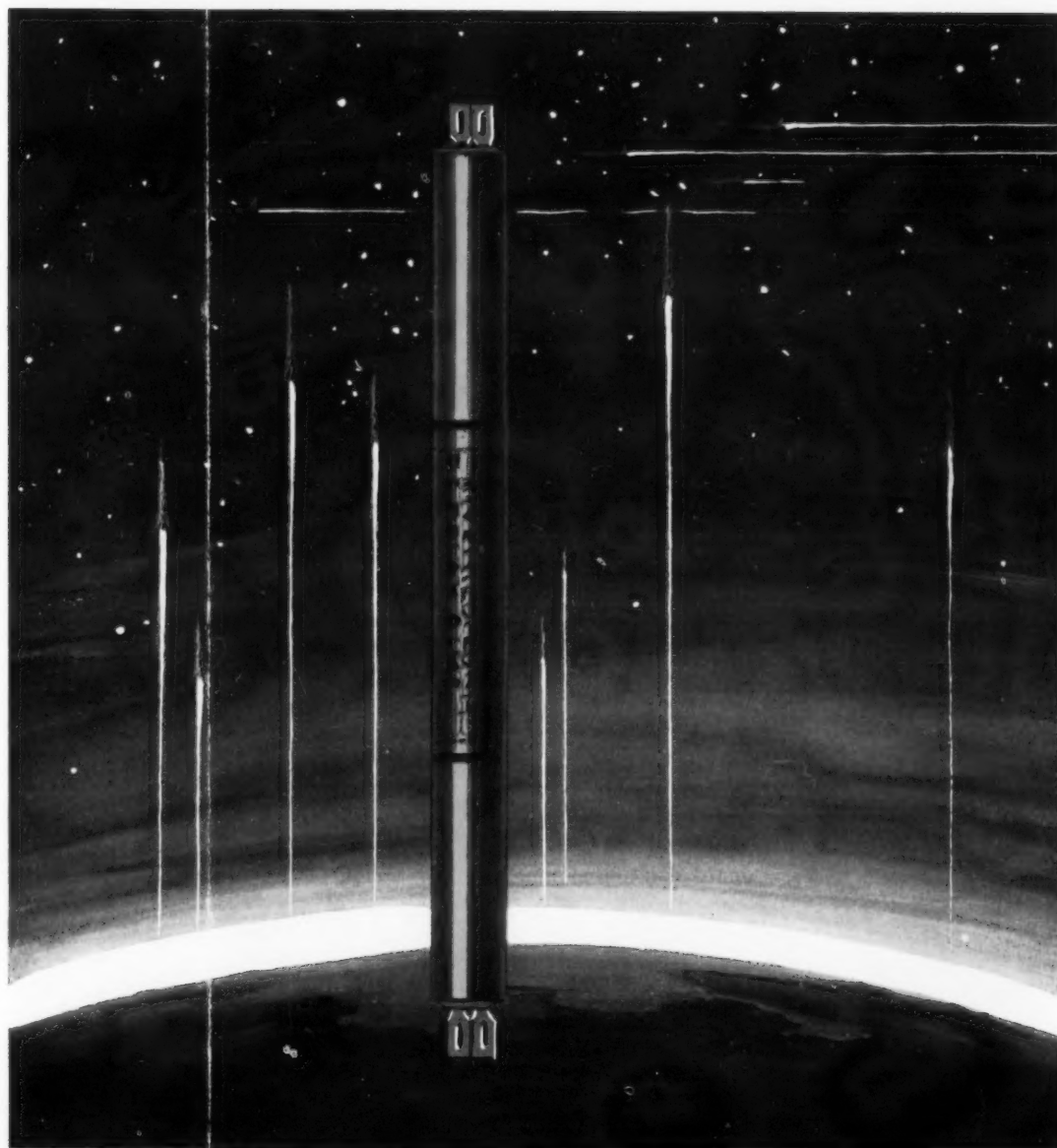
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cover article:

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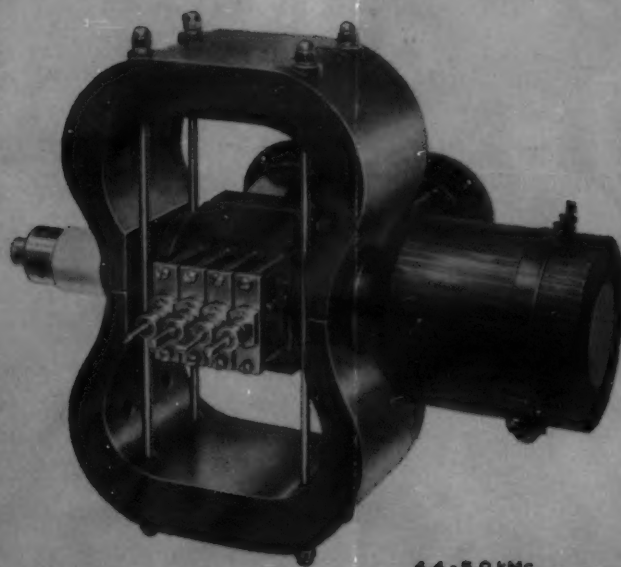


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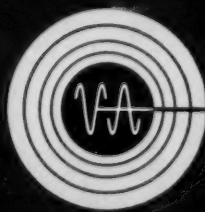
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CIRCLE 1 ON READER-SERVICE CARD



Published bimonthly by Instruments Publishing Company Inc., 845 Ridge Ave., Pittsburgh 12, Pa. Printed at 1600 N. Main St., Pontiac, Ill. Accepted as Controlled Circulation Publication at Pontiac, Illinois.



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(Commander U.S. Naval Reserve)

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PRINT ORDER THIS MONTH 36,300

VOL. 5, NUMBER 1
Jan.-Feb. 1961

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COVER: Reliability in combat, as suggested by the artist's conception of missile defense against a multifold air or missile attack, requires perfection of performance at the "moment of truth." The delay line, a key component in missile control, offers peculiar problems in achieving perfection of performance. (See page 8)

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January-February, 1961

now...find,
identify, analyze
noise & interference
1kc—25mc
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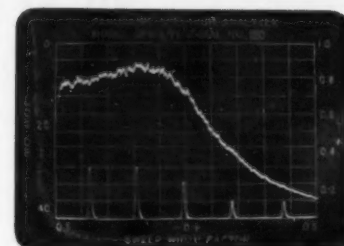
PANORAMIC's
economical
SPA-3/25
SPECTRUM
ANALYZER



Widely used for high-speed location, identification and analysis of random and discrete signals, the SPA-3/25 automatically separates and measures the frequency and amplitude of signals in spectrum segments up to 3mc wide, selectable anywhere between 1 kc and 25mc (usable down to 200 cps). Direct readouts of frequency distributions and amplitudes of signals are provided respectively on calibrated X and Y axes of a 5" long-persistence CRT. The SPA-3/25 samples the spectrum at a 1-60 cps rate.

Panoramic presentation of the Model SPA-3/25

1. permits quick location of signals, minimizes chances of missing weak signals or holes in the spectrum
2. speeds up measurements by eliminating tedious point-by-point plots
3. enables fast, reliable detection of comparatively low level discrete signals present in random spectra through use of adjustable narrow IF bandwidths and correlation techniques
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Noise spectrum analysis using internal video smoothing filter presents noise envelope average versus frequency in readily appreciated form. Internal marker pips are 500kc apart.

SPECIFICATIONS:

Frequency Range: 1 kc—25mc in 2 bands
Sweepwidth: Variable, calibrated from 0 to 3mc
Center frequency: Variable, calibrated from 0 to 23.5mc
Markers: crystal controlled, 500kc and harmonics to 25mc
Resolution: Variable, 200 cps to 30 kc
Sweep rate: Variable, 1 cps to 60 cps
Amplitude Scales: 20 db linear, 40 db log, 10 db square law (power)
High sensitivity: 20 μ v full scale deflection
Attenuator: 100 db calibrated
Response Flatness: $\pm 10\%$ or ± 1 db
Input Impedance: 72 ohms, High impedance probe-PRB-1—Optional

The SPA-3/25's great flexibility makes it a valuable tool in a wide range of applications. Write, wire or phone NOW for detailed specifications and NEW CATALOG DIGEST.

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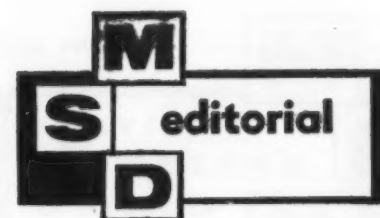
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Dawn of an Era

More than a routine change of Presidential Administrations took place in Washington, D. C., on January 20. Following a long period when international tensions have reached new dimensions, the change in U. S. leadership provides an opportunity for both the Communist and Western World camps to relax attitudes without "losing face."

Although President Kennedy's appeal for a "beginning toward achieving the new world of law" struck a note of high idealism, the inaugural speech held no suggestion of softness or capitulation to Communism. "Let every nation know—that we will pay any price, bear any burden, meet any hardship, support any friend, or oppose any foe in order to assure the survival and success of liberty." Also, his summons to Americans, "Ask not what your country can do for you—ask what you can do for your country," would appear to forecast a program of more work and sacrifices by a wider sector of the population rather than a tendency to settle for the easy popular course, the politically expedient.

We anticipate that moves to strengthen the combat readiness of the armed forces will be made by the new administration. Each proposal for change will have to win out over formidable opposition from many quarters, not only from within the separate services but in Congressional and Senatorial committees. This should assure careful consideration of all plans. Whether administration proposals will follow the "trial balloon" sent aloft by Senator Symington or be considerably modified should emerge in the next few weeks.

Shortly before Inauguration Day, Soviet Premier Krushchev, in a speech before Soviet Party heads in Moscow, stated that although the Soviets would support minor wars in the cause of "peoples liberation," a major war should result only "if capitalist nations try to resist Communism's victory"—which victory he termed "inevitable by the laws of historical development." We predict that any change in the U. S. military establishment will be designed to persuade Chairman K. to postpone the "inevitable," rather than toward achieving early relief for taxpayers.

In short, we do expect changes to be proposed and adopted, but that a heavy rate of expenditures for Defense and Space Agency projects will continue to be necessary.

Presidents Eisenhower and Kennedy are to be congratulated on the climate of good will and cooperation which characterized the transfer of administrative responsibility. Democrats and Republi-

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Du Mont's most recent contribution to the scope camera field, the Type 450, provides such field-requested features as interchangeable lenses for image ratios from 1:1 to 4.5:1 — and interchangeable backs — to provide records in any size from 4" x 5" to 35 mm. All lenses are equipped with synchro shutters and external electrical connectors for tandem, automatic or remote operation. Mounting mechanisms have been greatly simplified, plus rack and pinion focusing, for additional speed in recording.

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*Patents Applied For

For abbreviated performance data see specs below or EEM, 1960 edition, page 1263.

GENERAL RESISTOR SPECIFICATIONS

Type: Wire-wound, also carbon and metal film.
Range: .01 ohms thru 20 Megohms
Absolute accuracy: 1% thru .005% (at 25°C)
Relative accuracy: thru .001%
Long term stability: thru .001%
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MODEL 850

MODEL 103

MODEL 101

MODEL 102

ILLUSTRATED MODELS

MODEL 850 Meets Mach 3 requirements of MIL-P-25757A (USAF).

MODEL 103 Mach 5 total temperature probe can be used to temperatures of 1500 C°.

MODEL 101 Mach 3 total temperature probe. Meets requirements of MIL-P-25726 (USAF).

MODEL 102 Mach 3 Deiced total temperature probe. Accurately measures total temperature during deicing.

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January-February, 1961

cans alike can take pride in this effort which materially contributed to the Nation's security and international prestige in a critical period.

Americans take for granted the smooth transfer of military command from one civilian commander-in-chief to the other during a change in political administrations. This is a cornerstone of the American way of life. In his farewell address, President Eisenhower emphasized the importance of keeping military power in its rightful place—an obedient instrument of national policy—not in control of that policy. The cooperative avenues to world leadership proposed by President Kennedy, besides easing world tensions, should help diminish such "tail-wag-dog" tendencies to influence national policy.

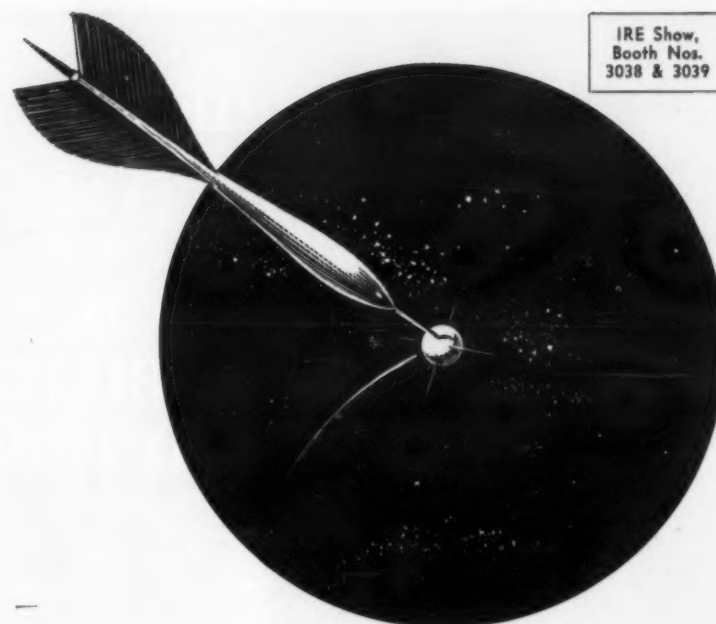
Changes in distribution and emphasis of military expenditures in the coming months will be important to every firm engaged in the production of systems and components entering into military support. Some of these trends are discussed on page 6. Others will be reported in later issues of MILITARY SYSTEMS DESIGN.

Timing Techniques in Systems Design

Various facets of the time-frequency-space relationship are editorially treated in this issue of MILITARY SYSTEMS DESIGN. Two of these are very closely related—the determination of exact time of day and the synchronization of oscillators at the same frequency.

These problems are of increasing importance because ballistic missile and space-probe controls require exact timing and professional accuracy. Because earth distances and locations are not precisely known, the difference between apparent times of day at different points on the earth's surface are also not accurately known. Because the time required to propagate a radio signal between two widely separated points on the earth's surface is continually varying, the correction of electronic frequency standards aboard nuclear submarines and other far-flung military operations becomes a major problem which is engrossing the attention of scientists in the Bureau of Standards and military research agencies. Your attention is invited to a partial review of these efforts in two articles in this issue. (Pages 23-24).

Another problem in timing arises from the need to accurately determine discrete time intervals of very brief duration in connection with fire control and missile location. Surprisingly enough, here the problem is not so much an extremely high degree of accuracy as the maintenance of stable characteristics under a wide range of environmental stresses. Delay lines are used in applications which can be accurately calibrated after manufacture, but which will malfunction if this calibration is not maintained. Reliability, rather than precision, is the paramount consideration in Delay Line techniques as described in the cover article in this issue. (Page 8).

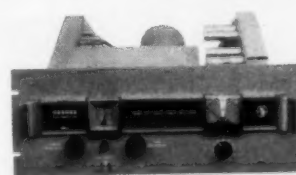


Pin-pointing the time dimension

To establish precise orbital parameters, Hermes Ultra Stable Oscillators, Model 101C, are being used as frequency standards in timing systems for Transit, Project Mercury, and Minitrack programs, and by many Missile Tracking Stations around the world.

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Write for Technical Bulletin USO



Guaranteed stability 5 parts in 10^{10} per day

Hermes USO, Model 101C. Also available . . . Regenerative Frequency Dividers providing outputs at 100kc, 10kc, and 1kc, and Frequency Multipliers providing phase stable outputs of 10Mc and 100Mc.

Hermes



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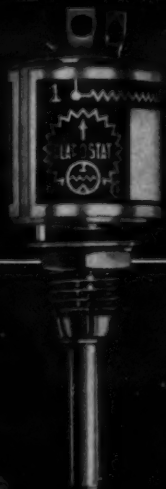
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SERIES 57EM HALF-INCH HIGH RELIABILITY POTENTIOMETERS

High Temperature Operation . . . 150° C



Here's performance to match those "beyond the usual" requirements in a compact, quality potentiometer. The Clarostat Series 57EM is now available with glass-sealed terminals to meet 150° C operating conditions.

Available in all common shaft configurations including set-and-forget types for trimming applications with split locking bushings.

These units are manufactured in accordance with the applicable sections of MIL-R-19, MIL-R-12934 and MIL-R-27208.

SPECIFICATIONS — SERIES 57EM WIRE-WOUND POTENTIOMETERS

• Diameter	1/2"
• Body Length	3 3/64"
• Maximum Resistance	100,000 ohms
• Linearity	2%
• Wattage	2.0
• Weight25 ozs

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CIRCLE 7 ON READER-SERVICE CARD

Letters

Editor, MSD:

Just a note to say I enjoyed the content and the philosophy of your editorial, "Technology and Foreign Aid." (Sept.-Oct. 1960 MSD). I feel there is a great hope in such a pursuit. While the war machine is a deterrent for the present, technological and humanitarian aid is the long term answer, I believe.

G. K. Douthwaite
Seattle 16, Wash.

Thank you. There is some evidence that gains in this direction will be made under the incoming Administration.

Editor, MSD:

The Kistler SLM quartz transducer, which I have used in the past, is a very high impedance device with 140 kc response. Static pressures (to several hundred psi) are easily read with this gauge. The sole drawback to the quartz transducer is a thermo-piezo electric effect which can in some applications give a spurious reading. I suggest you contact the Kistler Instrument Co., No. Tonawanda, N. Y. if you are interested in additional information.

I am particularly interested in how the new-piezo-resistive gauges compare to the quartz type in terms of response time to a sudden pressure pulse.

Thomas D. Wilkerson,
Project Matterhorn,
Princeton, Univ.,
Princeton, N. J.

The foregoing letter referred to the article, "Semiconductor Element is Major Transducer Advance," appearing in the Sept-Oct 1960 MSD in which the following statement was made: "The Piezo-resistive principle should not be confused with transducers of the piezo-electric crystal type that are responsive only to dynamic input pressures and are totally insensitive to static pressures. This class of transducers is relatively inaccurate." Upon receiving Mr. Wilkerson's letter we corresponded with Mr. R. W. Lally, Sales Manager of the Kistler Instrument Co. and Mr. Robert J. Feldheim, Advertising Manager for the Fairchild Controls Corporation, manufacturers of the new piezo-resistive transducer, requesting more information on the question posed by Mr. Wilkerson. The following are pertinent excerpts from their replies.

Editor, MSD:

As you probably know, the Fairchild Piezo-resistive Pressure Transducer has generated considerable interest and excitement in the industry, and if it proves to be as good as the claims indicate it certainly will be a significant achievement in the art of pressure measurements.

This instrument, in its present form is not competitive to Kistler Quartz Transducers in our major marketing areas. Your statement regarding piezoelec-

MILITARY SYSTEMS DESIGN

tric crystal type transducers is not completely inaccurate; however it does not do justice or credit to modern piezo electric crystal transducers. The piezo-electric effect is a completely static phenomena and with natural quartz crystal elements it is practical to statically calibrate these instruments and also to make accurate static measurements over limited time intervals. It is not the time constant of the input circuit as much as the temperature effects on zero drift that limits the static time interval. We are informed that this is also the very serious shortcoming of piezo-resistive elements.

As for the piezoelectric transducer being relatively inaccurate, we do not believe what there is anything that is as stable, as linear, and as repeatable as the natural quartz crystal element and its associated piezo modulus. With a comparable size diaphragm as employed by the Fairchild transducer we can easily match or exceed the specified accuracy, and to approach this figure with much smaller diaphragms. In addition, natural quartz crystal is not affected by either very high or very low temperatures.

We are enclosing a copy of our brochure which we believe will be of interest to your readers.

R. W. Lally, Kistler Instrument Corp.

The technical brochure mentioned above illustrates the Kistler Piezo-Calibrator in which an electrometer tube is used to read the static charge due to pressure without dissipation. Force-balance servos which accomplish the same purpose are also illustrated.

FOR THIS LITERATURE CIRCLE 115 ON READER-SERVICE CARD

Editor, MSD:

May I extend my sincere appreciation and admiration for the fine job MSD has done on the story entitled "Semiconductor Element is Major Transducer Advance" in your Sept.-October issue. As you know, several major publications have given our 3S-G transducer major editorial treatment. Your treatment surpasses them all in technical understanding and readability.

We regard your statement in column 3 on page 4 as absolutely correct. The quartz crystal type unit is used to measure vibratory-type forces and are not to be used for static pressure conditions. Further, the quartz crystal generates a very low emf.

"Static" conditions can be defined as those which exist where the pressure (or any other physical effect) is relatively unchanging or steady-state. Pressures in city water mains are relatively static. Voltages in high-tension transmission lines are relatively static. Barometric conditions are relatively static even in the eye of a hurricane.

"Dynamic" conditions can be defined as those which exist when the measurable effect is changing at a relatively high frequency. For example, the instant a missile lifts from the launching platform, intense vibration waves are known to sweep along its skin. An air-launched torpedo can encounter high-frequency dynamic conditions upon the moment of impact with the water. In the laboratory, shakerheads set up the kind of dynamic conditions encountered.

The 3S-G must be supplied with an excitation voltage, in this case from 10 to 25 v dc. It generates a usable output signal without the need of an external amplifier. The output from the solid-state sensing device by itself is in the order of 0.2 volts. The Fairchild sub-miniature solid-state dc amplifier, built into the 3S-G case amplifies the output signal to approximately 5.0 v, full scale. The 3S-G is responsive to both static and dynamic pressures.


For dynamic pressure applications, the frequency response ranges of piezoelectric devices and 3S-G devices overlap. Industry tends to favor piezoelectric devices for the upper bands of the frequency spectrum, the 3S-G for lower bands.

In answer to Mr. Wilkerson's question concerning the frequency response of the 3S-G it varies, depending on the designed pressure range of the instrument. For example, a unit designed for 1,000 psi full scale has a natural frequency of 30,000 cps. The frequency response of this unit is a percentage of this figure—certainly flat up to 1,000 cycles and capable of high accuracies to a frequency several times that amount.

The definition of zero drift is the change in the zero calibration point as a function of time—as the instrument is turned on and off over a considerable period of time. For example, if the instrument is operated one hour today, six hours next week and again three hours sometime next month, how much does the zero point drift? In the Fairchild 3S-G, zero drift is negligible. No additional compensation is required as the inherent characteristics of the instrument are designed to obviate the need.

Robert J. Feldheim
Fairchild Controls Corp.
Hicksville, L.I., N.Y.

FOR MORE INFORMATION CIRCLE 116 ON READER-SERVICE CARD




50 Megawatt "S" Band Radar Transmitter

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SHARP AS A SPORTSCAR: Each ALPA lens is individually film-tested for critical sharpness, perfect tonal contrast and brilliant overall illumination.

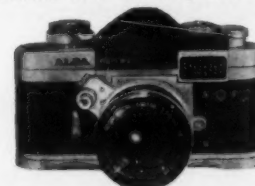


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Type 202: 20 cps to 500 mc. Accuracy 0.05° or 2%. 1° full scale sensitivity. Price — \$588.00.

Type 205-A1-A2: 100 kc to 15 mc. Accuracy 0.05° or 1%. Sensitivity 0.04 volt full scale. Price—\$625.00 and up.

Type 205B1 Series: 15 mc to 1500 mc. Accuracy 0.05° or 1%. Measures down to millivolt. Price — \$1193.00 and up.

Type 208 Phase Shifter: 0 to 360°, continuously adjustable. Accuracy 0.1°. Price — \$445.00 and up.

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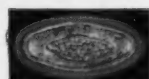
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CIRCLE 11 ON READER-SERVICE CARD

The Defense Market

An Examination of the Various Aspects of The Defense Market*

THE "top hundred" prime defense contractors are now obtaining approximately three-fourths of Defense Market procurement. Other large companies get about 10% and small business only about 15% (Fig. 1). (NASA and FAA budgets and programs were omitted from this study. However, the Avionic items in this budget are closely allied to and are believed to follow the same trends as shown for defense procurement.)

The trend in defense systems is toward electronics systems of greater complexity produced in smaller numbers. The total share of Aircraft and missile expenditures going to "Avionics" (electronics and related mechanical-electrical devices and systems used in aircraft and missiles) is continually growing (Fig. 2).

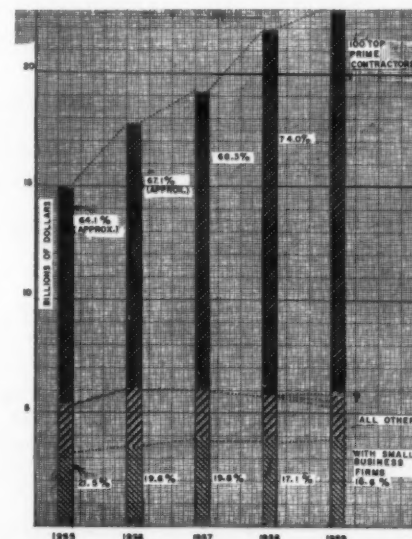


FIG. 1. MILITARY PROCUREMENT. Net value excluding intragovernmental, educational and non-profit institutions and works outside the United States.

During the last three fiscal years the markets for missile guidance, servosystems and missile airframe control, missile checkout equipment, telemetry and communications, and military type computers have markedly increased (Fig. 3). On the other hand, radar, aircraft controls and other aircraft electronics show a decrease in procurement commitments. Aircraft navigation systems, due to the military importance of controlling commercial as well as military aircraft, have resisted this decline most successfully.

The authors of the study conclude that the "boom years" of the defense electronics industry are probably over; that competition, the personnel and financial resources required to operate in the 1961

MILITARY SYSTEMS DESIGN

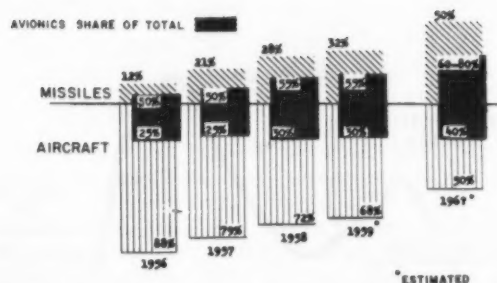


FIG. 2. AVIONICS share of total Aircraft and Missile Expenditures, FY 1956 to 1958. Percentages for 1959 and later are estimated.

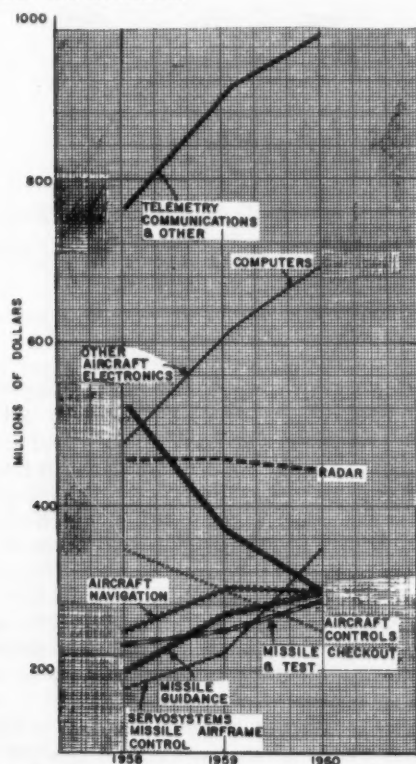


FIG. 3. TRENDS OF GROWTH for Missiles, tapering off for Aircraft components is shown in Avionics procurement figures for FY 1958, 1959 and 1960.

Defense market tend to favor the "big" company at the expense of the "small" firm. The report concludes:

"Of course there will be small company survivors. But these will not necessarily be the companies who pioneered, who advanced the state of the art. The engineering skills must be present, surely, but they will not be enough. Nor will the race go only to those who have the financial skills and sinews as well. The race will go to those who can add to these prerequisites the skills in management, the skills in marketing. This will be true for large as well as small companies."

*Abstracts from 32-page report by the Marketing Services Division of Smith, Winters, Mabuchi, Inc., Advertising Agency, New York, N. Y.

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SOLID-STATE PORCELAIN CAPACITORS

...chosen for reliability by

AUTONETICS* in

HOUND DOG'S Verdan Computer

Vitramon® Capacitors adapt easily to the printed circuit boards used in VERDAN. Note how square configuration and axial-radial design of capacitors permits flush mounting and easy insertion. Solid-state construction — fine silver electrodes molecularly fused with dense porcelain dielectric — give Vitramon® Capacitors outstanding stability, extremely low loss, and high pulse rate.

Autonetics' air-borne VERDAN is an extremely high speed computer with relatively high capacity, great flexibility of application, and extensive input-output provisions. Occupying less than 1½ cubic feet of space, VERDAN is designed with a general purpose section and a digital differential section, both of which share a common magnetic disk memory and have complete intercommunication. VERDAN was developed by Autonetics for its air-to-ground "Hound Dog" guidance control and REINS nav-bomb systems.

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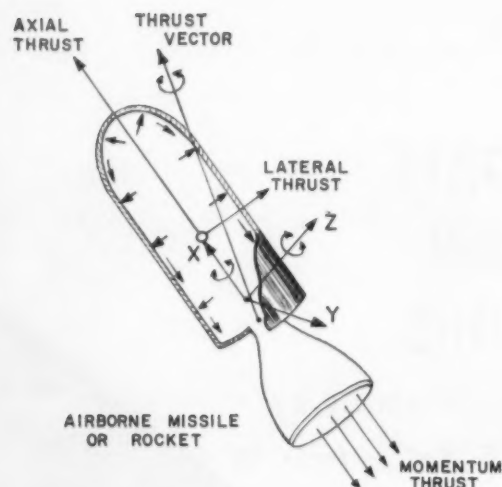


FIG. 1. STRESSES and vibrations set up at different stages of a missile's flight are complex and can only be determined from experimental flights. Some complex thrust factors are shown in this diagram.

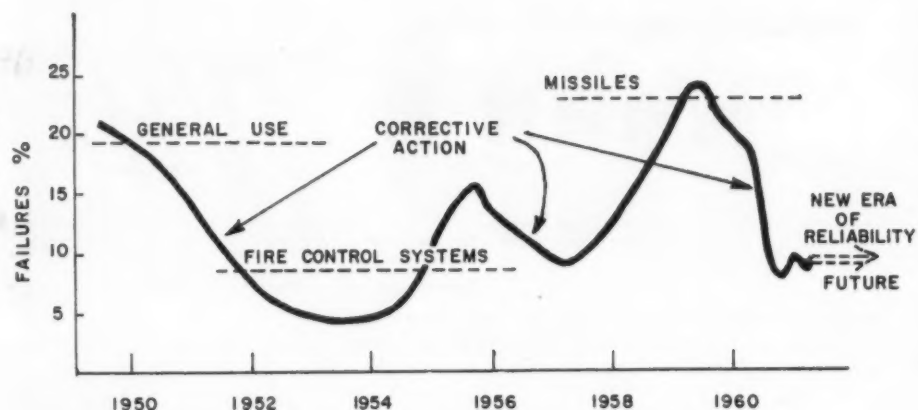
The reliability requirements of an electro-magnetic delay line are governed to a large extent by the overall reliability requirements of the complete electronic assembly or unit in which it is to be installed. Over-all reliability, like a chain, is only as strong as its weakest link.

Delay line applications—especially of the electro-magnetic type—have increased to the point where they appear in most equipment using pulse techniques, storage and timing devices. Such a delay line is classified primarily as passive four terminal network having the property that a signal impressed at the input terminals appears at its output terminals after a time interval called the delay time. Delays ranging from a few millimicroseconds to hundreds of microseconds are obtainable with electro-magnetic lines. Precision of the delay interval is less important than the stability of its performance.

Electro-magnetic delay line reliability is defined as follows: Continuous stability of performance with a minimum rate of deterioration of electrical characteristics over a specified time and within specified environmental conditions.

The importance of reliability of electro-magnetic delay lines is especially emphasized in the following applications: Missile guidance systems, radar systems, fire control systems, guidance systems, data handling, computers, and telemetry. In general, delay lines are used wherever signals must be compared or temporarily stored. In radar systems, a signal is stored (delayed) so that the returning signal which is bounced from an object may be compared. Frequently in computers and digital circuitry a temporary storage is needed and this is provided by a delay line.

FIG. 2. NEW ENVIRONMENTS mean new reliability problems. Average electro-magnetic delay line failures from all causes are graphed over a period of ten years experience.



Reliability of Electro-Magnetic Delay Lines

EARL C. RAU

Industrial Systems Division
Hughes Aircraft Company

Delay lines in most instances can be separated into two reliability categories, one for stationary and the other for airborne use. Delay lines in a fixed installation are generally governed by requirements not as rigid as those required in an airborne unit. The chances of a stationary unit being subjected to extreme conditions of vibration, shock and acceleration are at a minimum, and in some cases less stringent specifications may allow the manufacturer to design and produce a less costly unit.

However, other parameters to be considered in the design of both stationary and airborne units are the non-operating or storage requirements which are now incorporated in most of the military specifications.

In consideration of a design to meet storage requirements, most failures can be attributed to extreme or sudden changes in temperature (thermal shock). Other failures are due to moisture penetration with its accompanying contamination under extreme humidity conditions which often exist when in storage.

When designing a delay line to be installed in an airborne system and subjected to extreme environmental conditions, all component parts in the system, including delay lines, should be those which have been proved reliable by complete and exhaustive test programs. Another design reference source is field service information compiled on the operating conditions and direct reasons for component failures in the field.

Missile Reliability Specifications

Their use in the missile program has caused a general tightening of all reliability test specifica-

tions for electromagnetic delay lines. Many unforeseen failures have occurred, outstanding causes being temperature and vibration. Thrust and pressure measurements on actual rockets and missiles often reveal peculiar random vibrations at frequencies beyond the usual laboratory test requirements for approval of a new design. Parts were vibrated for several minutes in each of three mutually perpendicular axes in the range of 10 to 60 cps, the tests are now performed for 20 minutes at 10 to over 2,000 cps and in each position three times for a total of nine times. The complexity of some of the vibration, thrust, and pressure problems can be noted from Fig. 1.

The delay time of a delay line will change as the temperature of its environment changes. This variation in delay and consequent distortion of the delayed pulse is due primarily to changes in its engineered characteristics per unit of electrical length. Any adverse environmental conditions which will effect the following design characteristics; rise time, impedance, and attenuation, will effect the overall delay time requirements and also effect adversely the output pulse wave shape. Hence, the objective in delay line design is to minimize any electrical changes which deteriorate the quality and accuracy of timing of the delay pulse.

The two parameters that are most vulnerable to the changes are the capacitance and inductance per unit of electrical length. The stability of the ratio of these two parameters and the stability of relationships between adjacent and alternate increments of inductance and capacity are the primary requisites of electro-magnetic delay lines.

The ratio of inductance and capacitance in a delay line can be expressed theoretically by the equa-

tions: Inductance (L) = $T_d \cdot Z$,

Capacitance (C) = T_d/Z

Delay time (T_d) = \sqrt{LC} ,

and Impedance (Z) = $\sqrt{L/C}$

The distributed type of electro-magnetic delay line by the very nature of its construction is most vulnerable to design instability. In a distributed line, the capacitance and inductance changes are due to the temperature co-efficient of expansion of the base former and the dielectric films. On the average the best stability obtained in a distributed line is in the order of 200 parts per million per degree centigrade. However, by the judicious choice of construction materials and methods, impregnation processes, and particularly by avoiding capacitance build-up between windings, the present state of the art has produced stabilities in the order of less than 100 parts per million per degree centigrade.

The lumped constant type of construction, having the advantage of greater delay per volume with less attenuation, has achieved still better reliability. Condenser and core material manufacturers have done extensive cooperative research in producing "de-bugged" components so that lumped constant delay lines can be held to an overall delay stability of better than 50 parts per million per degree centigrade.

Techniques for Reliability Improvement

Faulty engineering in the development and prototype design stages is the major underlying reason for equipment failures. It appears that engineers striving for performance lose sight of reliability. This is largely due to non-use or misuse of normally reliable components. Engineers are not always at fault in this case, as crash programs usually result in the lack of adequate time to completely evaluate all supporting components and test data. Experience has proven that it takes thousands of hours designing, testing, redesigning and retesting to achieve almost perfect reliability. The challenge obviously is to learn how to build reliability into electronic equipment.

Many unforeseen failures plagued the early history of delay line development for military use. Predominantly failures were due to sudden temperature changes (thermal shock); shock, vibration, barometer pressure (altitude) and adverse humidity conditions (fungus growth). These problems were partly solved by the petroleum industry through its research in the field of resins, now being used in many applications including the potting and encapsulation of delay line assemblies. Resin materials at first were subject to cracking and also caused expansion and contraction of component parts. Further research developed semi-rigid resins and fillers to reinforce the resins. Pre-dipping of assemblies is also used to lessen the effects of constriction. In cases where components are very fragile the complete unit can be partially potted to provide mechanical strength and then evacuated, filled with inert gas under pressure and hermetically sealed. This method is most successful in coping with cases



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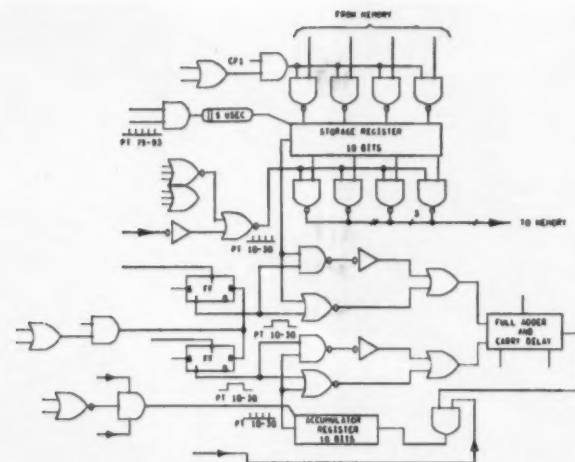


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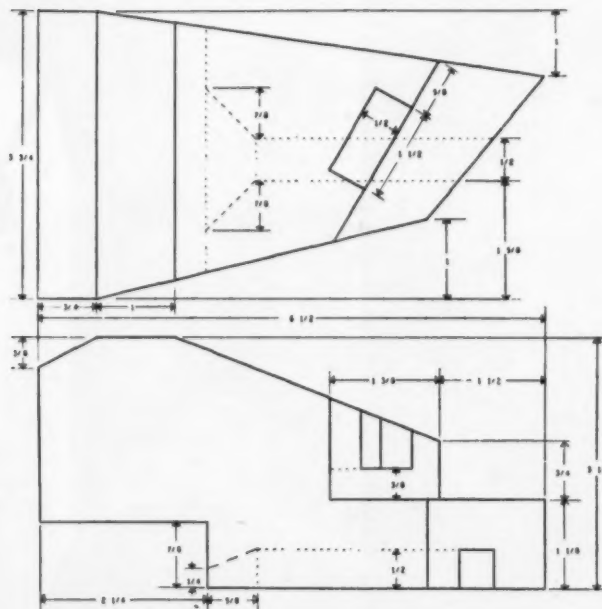
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Instantaneous mechanical drawing is now a reality, with the Stromberg-Carlson S-C 4020 High-Speed Microfilm Recorder. Automatic drafting can cut weeks from design time, saving invaluable engineering man-hours. Here's how it works:

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A DIVISION OF **GENERAL DYNAMICS CORPORATION**
CIRCLE 14 ON READER-SERVICE CARD



FIG. 3. POTTED DC delay lines for Avionics are temperature-cycled to relieve stresses.

of extreme temperature change, where electrical stability and insulation resistance are subjected to extreme heat. This method also has the advantage of light weight in airborne equipment. One of the latest potting methods uses high-temperature-resistant "foam-in-place" resins. The rigid foams are very light, yet maintain a fair degree of mechanical rigidity under stress. The foaming process has a minimum effect on the electrical characteristics if each part or completed assembly has been first impregnated with a resin or high quality radio frequency varnish and then temperature-cycled to stabilize the electrical characteristics. Temperature-cycling of potted delayline assemblies is effective in relieving internal stresses. Such assemblies can then accept temperature or vibrational shocks in service without drastic distortions in pulse characteristics which constitute a reliability defect.

Design techniques in delay line construction which may incorporate components of questionable quality should be approached with caution. Such radically new designs should not be accepted into the family of proven reliability until a favorable case history record based on actual in-service field reports is available.

Life testing of an electromagnetic delay line is usually performed at the conclusion of the complete environmental program. Accelerated life tests are now being devised to more realistically simulate actual operational requirements under captive conditions. Accelerated conditions of voltage and temperature stresses, vibration, and humidity, etc. are based on analyses of failures in the field. This method has been applied over the last decade as delay lines have moved into progressively more hostile environments (Fig. 2).

The following empirical formula provides an estimate of the effect increased voltage and temperature may have in accelerated tests of electromagnetic delay lines.

$$L_2 = L_1 \cdot E^8 \cdot 2 \frac{(T_1 - T_2)}{10} \quad \text{where}$$

L_1 = Life in hours at the elevated voltage and the elevated temperature.

L_2 = Life in hours at the reduced voltage and the reduced temperature.

E = Ratio of elevated voltage to reduced voltage.

T_1 = Elevated temperature in °C.

T_2 = Reduced temperature in °C.

This type of life testing has been most helpful in "de-bugging" capacitor failures which a few years ago were one of the sources of greatest concern. The findings of the present stepped-up life testing programs may usher electromagnetic delay lines into a new era of reliability.

FOR MORE INFORMATION ON DELAY LINES
CIRCLE 117 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

Windows Into Space

Multi-layer anti-reflection films can now be vacuum-deposited on large viewing ports to provide a window to the universe for the first human Mercury Capsule passenger. Equipment and the process of large area deposition (Fig. 1) are developments of the Optical Coating Laboratories, Inc., Santa Rosa, Calif.

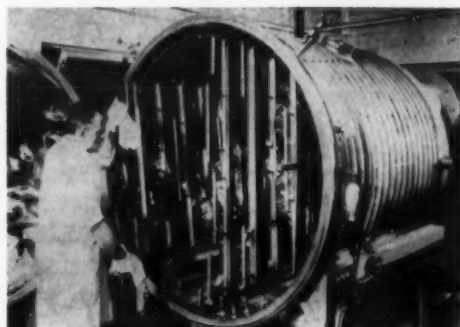


FIG. 1. REMOVING RACKS of large, deposited-film beam splitters from 60" coating chamber.

Already in use on the TIROS, RANGER SAMOS, MIDAS, COURIER and other satellites, OCLI thin films are being used as emissivity-enhancing cover slips for photovoltaic cells. This film reflects the ultraviolet radiation, which is unattenuated by atmosphere out in "satellite territory," to improve the conversion efficiency of the power-producing cells.

Another product of the OCLI research, developed at the request of the North American Aviation's Autometrics Division, is the thin-film trichroic reflector which utilizes the phenomenon of "contrast enhancement." The trichroic reflector virtually excludes all transmitted energy at 520 μ with transmission of light to less than 0.1%. This reflector is used in the Pilot Display Projector, which projects transparent images of navigation and landing aids directly onto the pilot's window-screen.

Thin films also make possible "hot" and "cold" mirrors constructed either to reflect the infrared while transmitting the visible light, or to transmit the infrared while reflecting the visible light. Such mirrors have important uses in high-intensity photographic projectors where excessive heat cause the film to distort or burn.

New facilities occupied in 1960 by the Optical Coating Laboratories, Inc., include a 2,000 sq-ft business office building and a 12,000 sq-ft production and research center. The production center contains 25 production chambers ranging from 18" diameter glass bell jars to 60" diameter stainless steel chambers. Five precision spectrophotometers are used in the research department to measure the characteristics of the complex multi-layer interference filters designed and manufactured by OCLI. The Optical Coating Laboratories, Inc. is said to be the only company devoted exclusively to the development and production of vacuum-deposited thin films and the nation's largest producer of interference type infrared filters.

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THE ONLY COMPLETE LINE OF BALANCED ROTARY RELAYS

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INTRODUCING the NEW Hi-G *“dice cube” relay

(Created Specifically for
Printed Circuit Applications)

Volume — $\frac{1}{8}$ cubic inch max.
Package Density — 8 per cubic inch,
13,824 per cubic foot.

Type: Model C Relay.
Contacts: SPDT, dry circuit to 1
amp resistive.

Temperature: -65°C to $+125^{\circ}\text{C}$.

Insulation Resistance: 1000 megohms @ 125°C .

Dielectric Strength: 1000 VRMS @ Sea Level.

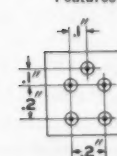
Convenient Size: $\frac{1}{2}$ " Cube, allowing best
compatibility in size to other printed
circuit components.

Optional Terminals: Long or short leads
for printed circuit applications, or hook
type for standard wiring.

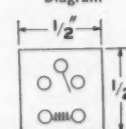
Construction: Balanced armature con-
struction, proven the best approach
available for resistance to extremes of
vibration and shock, exceeding all pres-
ent military specifications.

Environmental Characteristics: To meet
all military relay specifications for com-
ponents of this size.

Printed Circuit
Features



Diagram



*Trade Mark of Hi-G, Inc.

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BRADLEY FIELD, WINDSOR LOCKS, CONN.

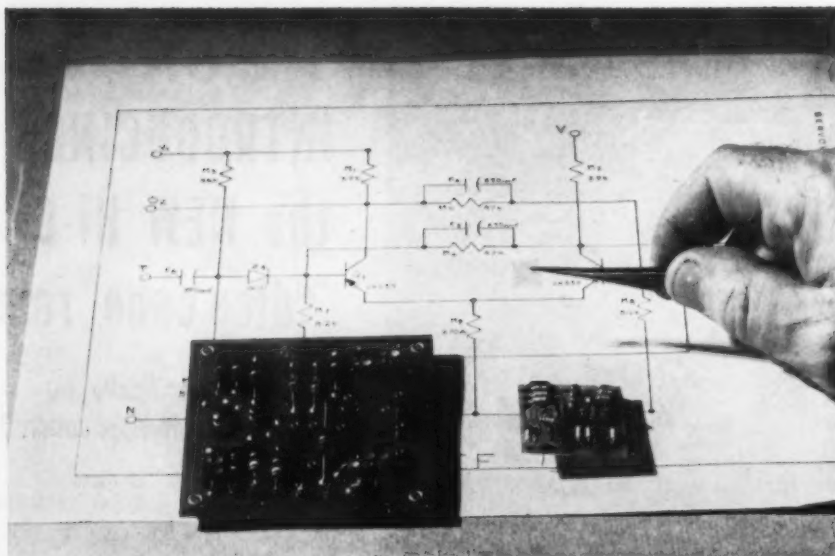


FIG. 1. MICROMINI-TURIZATION of a flip-flop circuit proceeds from a unit with conventional size components (left) to miniaturized printed-circuit board (right), and finally to micro circuit on 0.35" x 0.35" substrate wafer held in tweezers.

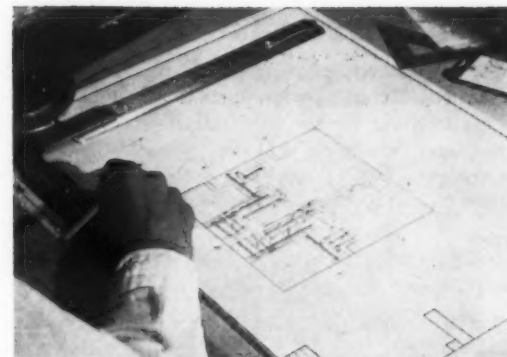


FIG. 2. TWO-DIMENSION layout of deposited elements is made after study of circuit values.

Design of Vacuum Deposited Microcircuitry*

by H. J. WEBER

Research Div., Servomechanisms, Inc.

IN THE DESIGN of an electronic circuit the development engineer must consider frequency requirements, temperature range, power requirements, input and output specifications, size limitations, and reliability. This article discusses the design of a vacuum-deposited micro-circuit, from initial design to final test.

The circuit selected (Fig. 1) is a bistable multivibrator or flip-flop containing a set, reset, and trigger point. The large circuit board is a standard version of this circuit and measures 2 3/4" x 2 3/4" x 1/4". The small circuit board, a miniaturized version of this circuit, uses standard components and measures 1 1/4" x 1" x 1/4". The wafer being held in the tweezers is a Signal Corps micromodule substrate (similar to the "tinkertoy" approach) and measures 0.3" x 0.3" x 0.020". SM/I's objective was to shrink the complete module on the left to the di-

mensions of the Signal Corps wafer. The module consists of 10 resistors, 5 capacitors, 4 diodes, and 2 transistors, a total of 21 components.

Before the circuit schematic can be reduced to a two-dimensional layout (DOFL) approach, the Graphic Arts Group prepared a layout (Fig. 2). The circuit schematic is used as a guide in allocating the areas for the resistor, capacitor, and conductor patterns. Large areas are reserved for the five capacitors.

For this flip-flop, the pulse repetition rate is 1 mc, the temperature range is -55° to +85° C, and the power requirements are 20 mw. A difference of 3 orders of magnitude in volume from the original size as well as a reduction of 80% in power was realized.

Capacitor Elements

For the capacitor elements the choice of a dielectric was narrowed down to silicon monoxide. Although we are constantly evaluating various other refractory oxides (such as the oxides of aluminum, zirconium and cerium) as dielectrics, we have had good success in the deposition of pin-

hole-free capacitors using silicon monoxide. Some of these have voltage ratings of better than 200 v and we can deposit 0.05 microfarad in one square inch.

Resistor Elements

Although SM/I has had years of experience in the deposition of nichrome as a resistor element, a variety of refractory components such as titanium carbide, boron carbide, and molybdenum disilicide have been investigated. These materials indicate a high resistivity (100,000 ohms per square and higher), and are potentially highly stable because they have tight atomic bonds and are oxidation resistant. However, our nichrome depositions have been evaluated thoroughly and have characteristics suitable for this microcircuit. Our experience indicates ability to deposit resistors of 1/10 to 1/4 watt with (1) excellent stability, (2) temperature coefficients of 50 to 150 ppm/C°, (3) an ohms-per-square value of up to 1500. The decision to use

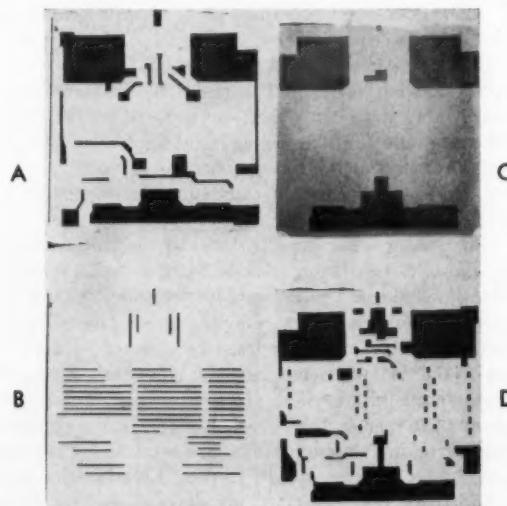


FIG. 3. FOUR DIFFERENT masks are required for the four layers deposited in passive components of flip-flop circuit. A and D are conductive patterns, B is resistor pattern, C is dielectric pattern.

*This article is based on a talk presented 1 June 1960 before IRE Professional Groups on Electron Devices and Component Parts, at the Institute of Applied Sciences, Los Angeles. The author is chief development engineer, Servomechanisms, Inc., Research Div., Santa Barbara Airport, Goleta, Calif.

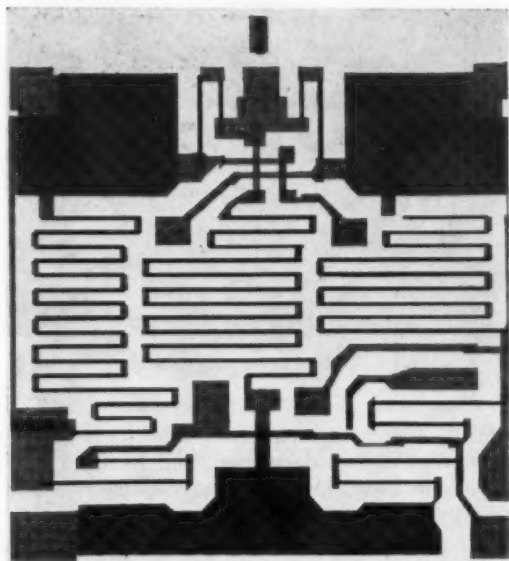


FIG. 4. COMBINED mask patterns show composition of circuit.

nichrome caused the area of the substrate to be established at 0.35"x0.35", a small increase in size, to enhance the reliability of the circuit at this time.

Conductive Materials

For conductive materials we have used gold, silver, aluminum, and nickel-iron films. Although gold has the lowest resistivity (in the order 1×10^{-6} ohms-cm) its adherence to the substrate material has not been as good as that of nickel-iron and aluminum, without special pre-conditioning.

Masks

The design layout then was drawn twenty times size on ruby studnite mylar film, and photographically reduced to make the four different masks for the vacuum deposition of the circuit shown in Fig. 3. Mask A represents the conductive pattern,

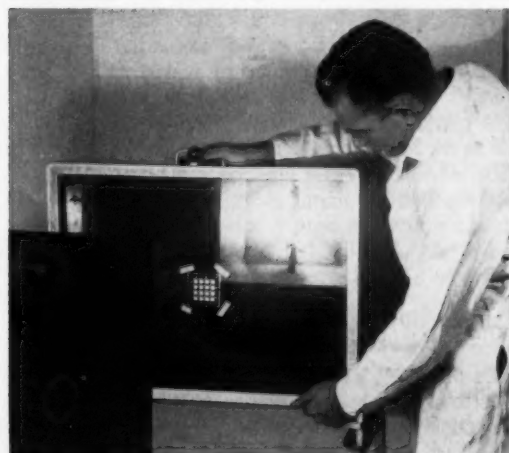


FIG. 5. PHOTO-RESIST coated stainless steel is exposed to arc through positive mask patterns.

vernistat[®] design report

Information on Vernistat[®] a.c. potentiometers for design engineers

TERMINAL CONFORMITY—THE RAINBOW AT THE END OF THE POT

Let's run with the basic facts: the Vernistat is a precision a.c. potentiometer. It differs from the ordinary pot because the input voltage is spread across an evenly and precisely tapped autotransformer. A low-resistance interpolating pot, which operates between adjacent taps of the autotransformer, pulls out a smoothly-rising, precisely linear voltage.

IMPEDANCE

The input voltage of the Vernistat looks into a **very high** impedance because the autotransformer consists of many turns of wire around a high-permeability core. The load, however, looks back to a **very low** impedance, because output impedance of the Vernistat is determined mainly by the resistance of the interpolating pot. Hence, as far as the load is concerned, the impedance of the autotransformer never goes above a few ohms.

"Now what", you may ask "has this high Z_i — low Z_o ratio got to do with linearity?"

Simply this: In addition to high initial terminal conformity, the Vernistat has an extremely low loading error. Output voltages remain linear and accurate!

To give this statement figures: if a 500 K load is applied to an ordinary 50 K pot, a maximum loading error

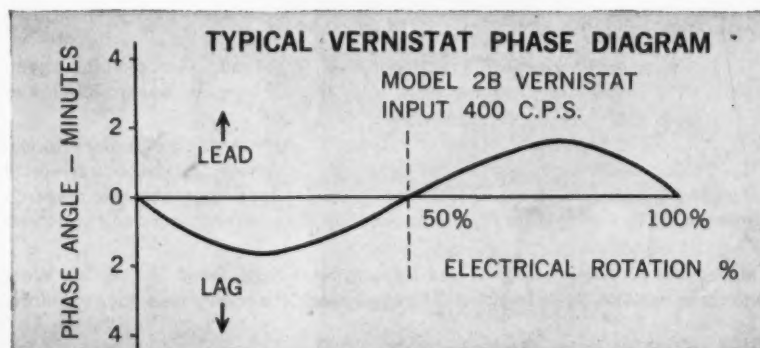
about 1.4% will result. This obviously is ruinous to system accuracies requiring a linearity of $\pm 0.1\%$ — a common figure in analog computer and servo work. With the same 500 K load, a Model 3B Vernistat goes to the head of the class with a maximum loading error of only $\pm 0.008\%$.

PHASE SHIFT

What's more, if phase shift is a problem, the Vernistat may well be your answer. The tapped autotransformer acts as an almost perfect voltage divider. That is, tap voltages remain almost exactly in phase with input voltage! (Take a look at the phase diagram below). Unlike many voltage dividers, the Vernistat does not develop excessive phase shift at higher frequencies. Operation at 5 KC is not uncommon.

In sum: the Vernistat provides high angular resolution (0.002%) and high linearity. It operates with essentially no power losses and can be continuously rotated.

Paradoxically, the Vernistat can be made into an excellent nonlinear potentiometer simply by varying tap distances of the autotransformer. Other nonlinear variants of the Vernistat are available, too. Ask us about our Adjustable Function Generators.



Yes, there may be a pot of gold under the rainbow for the designer who realizes what Vernistat can do to reduce size and weight of equipment and increase reliability and accuracy. But first you've got to know! So, send for our design literature. It's downright enlightening!

CIRCLE 16 ON READER-SERVICE CARD

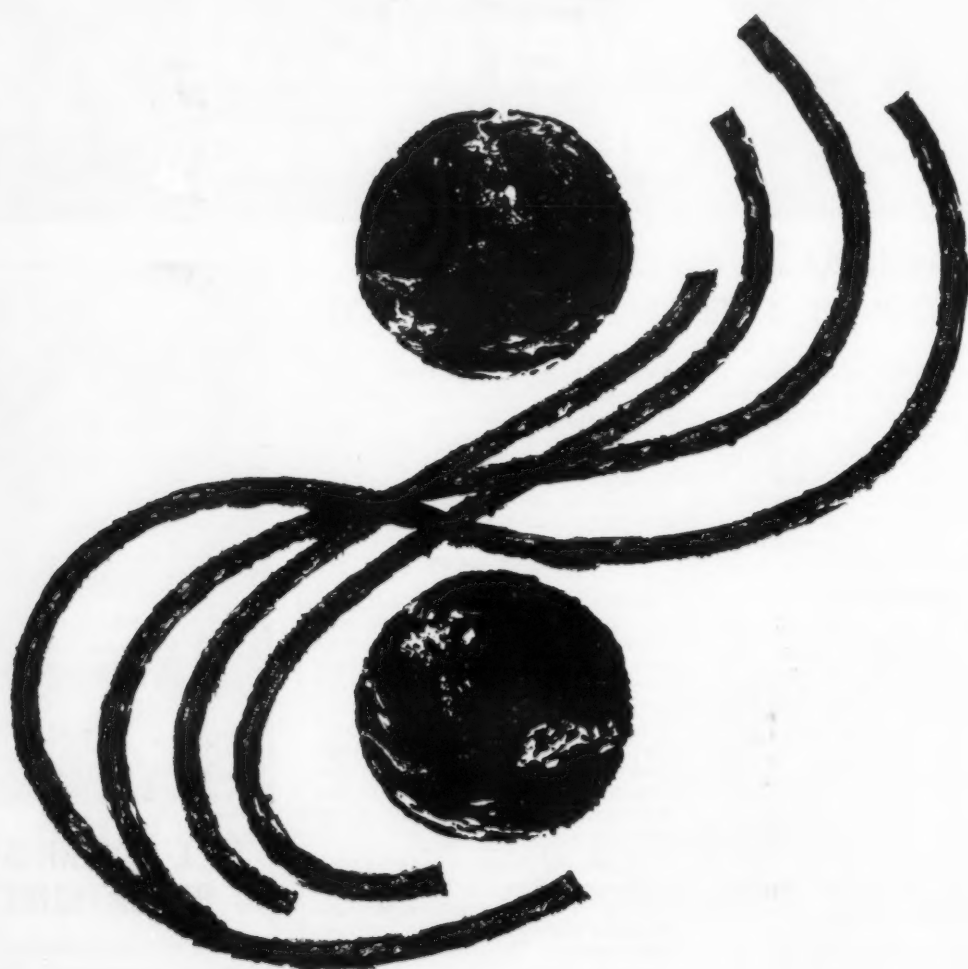


SIZE II VERNISTAT AC POTENTIOMETERS

These miniature, ten-turn components are approximately $1\frac{2}{3}$ inches long, a little over an inch in diameter, and weigh only 2 ounces. The Series 4 operates at 400 c.p.s. at 20-40 volts maximum input. Input impedance is 2,500 to 30,000 ohms; output impedance, 40 to 200 ohms. Terminal conformity is $\pm 0.05\%$. Series 4 Vernistats are 10-turn units and provide continuous rotation, since they have no stops.

Four Series 4 Vernistat models are available which cover the above ratings. They are useful as data transmitters, computer elements, driving elements for resolvers, servo follow-up components... for mathematical operations, voltage step-up, and phase reversal. Write for complete data on these high-precision components today!

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Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-14E, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

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FIG. 6. SUBSTRATE blanks are cleaned in dust-free environments.

Mask B is the resistor pattern, Mask C is used for dielectric material deposition, and Mask D is the conductor layer to make the capacitor counter electrode.

The first deposition was that of the resistors. The conductor pattern was then deposited over the resistor layer and the dielectric material was then deposited. The fourth and last deposition was that of the counter electrode for the capacitors. The final circuit of this flip-flop looks like the composite of the four masks (Fig. 4). (Other techniques use as many as 17 depositions, thereby reducing the reliability of the circuit, as well as the yield).

The masks are produced in the following manner in the SM/1 Laboratories: A sheet of stainless-steel stock, 2 to 5 mils thick, is prepared by applying a photo resist emulsion on one side of the material. A spinning table is used in order to make a uniform film of the photo resist emulsion on the stainless steel. An infrared lamp is used for drying the photo resist on the mask material. The stainless steel stock bearing the photo resist emulsion is placed on the vacuum printing frame (Fig. 5), and a positive film of the desired mask layout is placed in front of it. An arc light is used to expose the emulsion and the mask is then placed in a developer solution. When the mask has been developed, it is next dipped in a dye tank to facilitate subsequent inspection and immediately placed under a cold water spray to wash off the unexposed resist. The mask is then inspected and placed in a ferric-chloride oscillating spray etcher. When the mask has been etched the resist is washed off with solvent and the mask is ready for use in the electron bombardment chamber. The substrate material, in the meantime, has been subjected to cleaning procedures carried out in compartmentalized dust-free areas (Fig. 6).

Vacuum Deposition Method

The process of depositing the nichrome resistance material uses a vacuum chamber with a tungsten filament as the cathode and a nichrome rod as the anode. A controlled potential difference of approximately 1500 v is established under high vacuum (approximately 10^{-6} mm. Hg) and the



FIG. 7. VACUUM-DEPOSITION Chamber with two towers, one for nichrome resistor deposition and one for conductor deposition permits more processing per pump-down.

anode is bombarded with electrons, causing it to vaporize onto the substrate material in the configuration of the mask outline. Fig. 7 shows the chamber cover being lifted and gives a view of two towers. One is used to deposit nichrome; the other is used for the deposition of the conductor pattern. Fig. 7 also shows the radiant heaters which are used to uniformly heat the substrate material to produce an adherent film deposit.

Addition of Active Elements

After the passive elements have been deposited, they are measured, inspected and evaluated. Resistances are read on a wheatstone bridge and values recorded. The capacitors are measured and their voltage breakdown determined. The active elements and the diodes must now be attached to the vacuum deposited circuit.

The transistors we use are silicon chips—unencased versions of the 2N697 and 2N706 silicon mesa transistors. In order to fully document the information about each transistor received, each silicon chip was mounted on a 1"x3" glass slide. Photographs then are taken of their characteristics as determined by a curve tracer.

Transistor leads are attached by a method of thermo-compression bonding that applies heat of the proper temperature and pressure to a point source thereby fusing the gold wire to the substrate material. The tedious task of soldering is eliminated and the reliability is improved. After the transistor is incorporated in the circuit, the unit is given an operating test. Plug-in test parameter boards are used in determining the electrical characteristics of the vacuum deposited circuits.

The foregoing illustrates typical activity of SM/T's Research Division in the microminiaturization of digital modules which include multivibrators, trigger circuits, exclusive and inclusive "ORS", "AND" circuits, and others designed to give the systems engineer the ability to assemble the smallest and most reliable systems possible.

FOR MORE INFORMATION CIRCLE 119 ON READER-SERVICE CARD

Thousands of Slip Ring Assemblies for Rotating Radar Antenna Systems

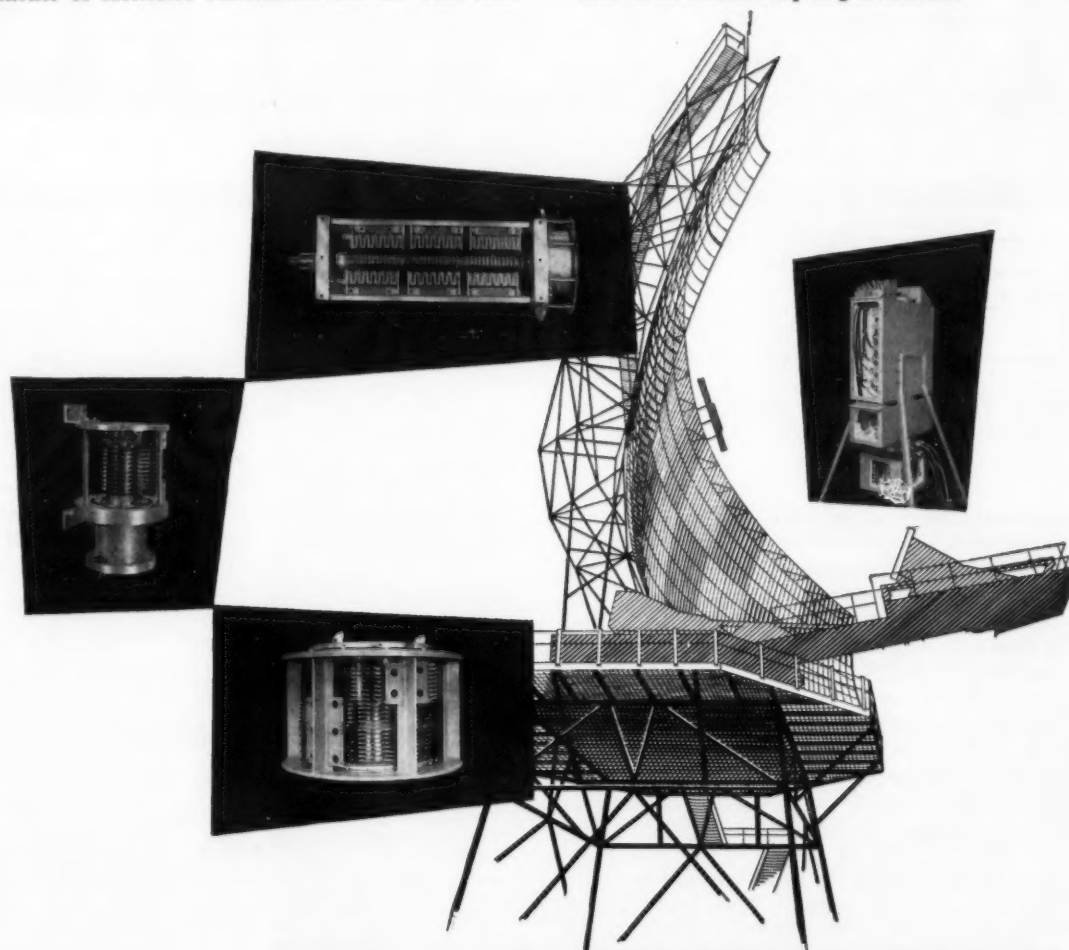
That's the Breeze Corporations' experience record in designing and producing slip ring assemblies for radar applications ranging from small shipboard and airborne antenna mounts to five-story-high giants used in ground early warning systems. With this experience record behind it, the Breeze organization is well-staffed and equipped to design and produce a slip ring assembly for any radar application.

Because many of these applications require assemblies having similar size and operating characteristics, Breeze offers a line of standard assemblies with ring envelope diameters from 1" through 10½". These are flat, stacked assemblies of fabricated construction and are built from

off-the-shelf components for rapid delivery at reduced costs.

Breeze also produces flat, concentric and cylindrical custom slip ring assemblies for radar application requirements which include general purpose control and power, radio frequency and video, high voltage and switching. Depending upon the application, Breeze custom assemblies are made by any of the basic methods of production: fabricated, electroplated and plastic molded.

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CIRCLE 17 ON READER-SERVICE CARD

Electronic Circuitry

A continuing **MILITARY SYSTEMS DESIGN** feature, these circuits are selected because they represent good design. Significant characteristics which are not self-evident from the diagram are explained in the printed commentary.

AUTOMATIC REARVIEW MIRROR DIMMER

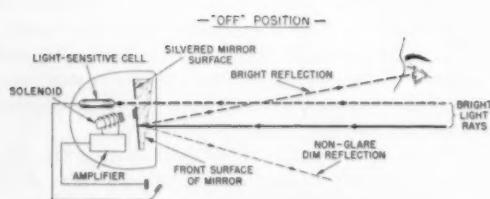


FIG. 1. AUTOMATIC TILTING of Rearview Mirror is interesting photocell application.

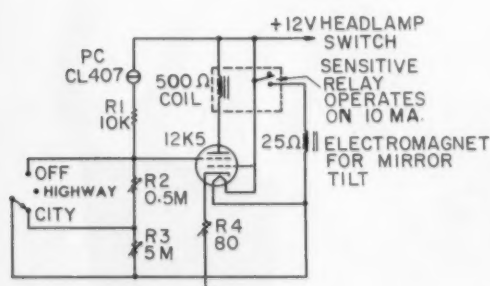


FIG. 2. "MIRROR-MATIC" circuit operates directly from 12-v dc.

Automatic tilting of an automobile anti-glare rear view mirror is accomplished on Chrysler Corporation automobiles by a photoelectric circuit (Fig. 1) and an associated mechanism. A photocell (CL 407) mounted at the mirror detects the annoyance level of light from following cars. The output of the photocell is amplified by a 12K5 space-charge tetrode, which operates a 50-mw relay. The relay in turn energizes a solenoid which tilts the wedge-shaped rear view mirror. A difference of about twenty to one exists between the intensities of light reflected from the two wedge surfaces. When the annoying glare disappears, the mirror returns to its high-reflectivity position. Optimum visibility from the mirror is provided at all times, without requiring the driver's attention.

The circuit (Fig. 2) operates from the car's 12-v electrical system. On 1959 models, a switch on the front of the mirror provides sensitivities of 0.1 foot-candle for city driving and 0.01 foot-candle for country driving. An "off" position is also provided. The 1960 model provides continuous control of sensitivity by means of a potentiometer.

A special Clairex type CL407 photocell is used. Its

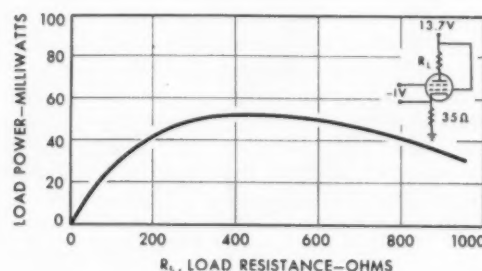
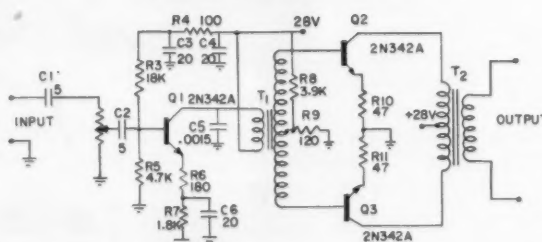


FIG. 3. OUTPUT vs LOAD characteristics of 12K5 tetrode operated on 12-v battery.

decay characteristics are such that the photocircuit has a 5-second delay time before the mirror returns to the normal position after impinging illumination is removed. The photocell is in series with a grid resistor (Fig. 2), across the 12-v supply. When light strikes the photocell, its resistance decreases (Fig. 3). Decreasing the photocell resistance increases the grid voltage. This in turn increases the 12K5's plate current, which flows through the 500-ohm relay winding. The cathode resistor (R4) develops a bias voltage to reduce the plate current to near zero in the absence of signal from the photocell. The effect of the space-charge-grid current through R4 also tends to regulate the plate current against supply voltage changes. R4 is factory adjusted to optimize the performance of the particular photocell, tube, and relay combination.

Source: George E. Platzer, Jr. Physics Research—Eng. Div., Chrysler Corp., Detroit 31, Mich., also *IRE Transactions on Industrial Electronics*, July 1959.

INTERCOM AMPLIFIER



A transistorized intercommunications amplifier circuit (Fig. 00) said to exceed the requirements of MIL-

E-5272B uses three TI 2N342A silicon transistors, with standard 2N342A matched pairs used in the push-pull final stage. Transformer coupling into and out of the push-pull stage results in a straightforward uncomplicated circuit. An 180 ohm resistor in the emitter of the first transistor and 47 ohms in the output transistor emitter supply degenerative feedback for the amplifier.

Power Output: 150 mw from -55° to 100° C at less than 10% harmonic distortion.

Frequency Response: Flat within 2 db of 1000 cps 100 mw reference level from 200 to 8000 cps.

Power Requirements: 28 v dc at less than 50 ma.

Input Impedance: 600 ohms nominal

Output Impedance: 600 ohms

Gain: Approximately 40 db

Source: Texas Instruments Incorporated, Semiconductor-Components division, P. O. Box 312, Dallas, Texas.

TRANSISTOR CIRCUITS

Small Signal Parameters

(Third Article in a Continuing MSD Series)

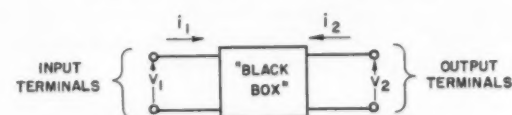


FIG. 1. AMPLIFIER circuit is described by two independent, two dependent, variables.

Behavior of any electrical circuit can be expressed in terms of mathematical expressions defining the relationships between the currents, voltages, resistances, inductances and capacitances of the circuit. These quantities, which can be measured directly or indirectly, are called the circuit *parameters*.

Simple devices, such as a resistor, can be represented by a single parameter. Other devices, such as a vacuum tube or a transistor, are more complex but can be represented by an *equivalent circuit* in which the actual device is replaced by combination of parameters, which, taken together, would behave the same as the device. These include passive parameters such as resistance, inductance and capacitance; and active parameters such as voltage and current generators.

An equivalent circuit for any amplifier can be expressed as a "black box" with two input terminals and two output terminals (Fig. 1). From measurements on the input and output signals we can determine many characteristics of the circuit contained within the box. Typical measurable ac parameters are input voltage and current and output voltage and current. If any two of the four parameters are selected as independent variables, the second two become dependent variables, which can be defined in terms of the first pair. Thus if the voltage v_1 and v_2 are selected as the independent variables, $i_1 = f_1(v_1, v_2)$ and $i_2 = f_2(v_1, v_2)$. These parameters are sometimes used in tran-

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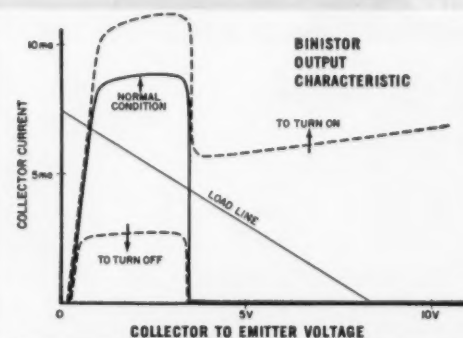
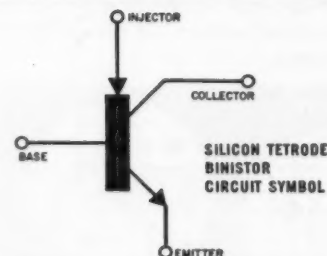
BINISTOR

(BY-NIS-TOR)

The Silicon NPN Tetrode binistor is a new component and a new concept for the circuit designer!

The key parameters of this bi-stable, negative resistance device are determined by external circuitry in contrast to existing devices. The significant reduction of peripheral circuitry results in outstanding savings in cost, space, weight and solder connections. For example, a typical flip-flop requires at least 13 components versus only 4 in an equivalent binistor stage. Very large current and voltage gains are realized in both on and off directions. Inputs and output are compatible in level with typical transistor and diode circuits. The tetrode binistor can operate from -80°C to $+200^{\circ}\text{C}$.

To learn more of this important new development — THE BINISTOR — and how it works — write for Bulletin No. TE-1360.



CONDENSED SPECIFICATIONS TRANSITRON BINISTOR

Typical Turn-off Current Gain	50 @ 15ma Collector Current
Operating Collector Current Range	50 μa to 15ma
I_{c} critical	0.5ma @ 5ma Collector Current
Operating Temperature Range with-out Temperature Compensation	-65°C to 150°C

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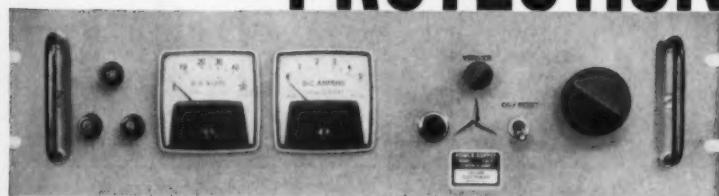
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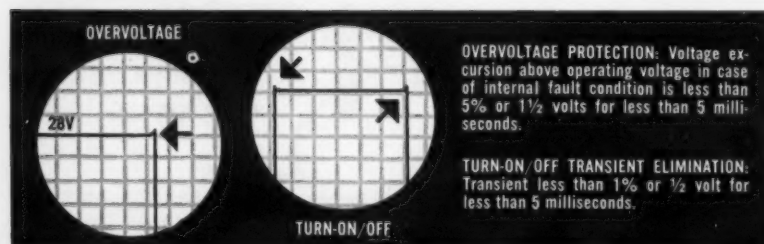


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MODEL	DC OUTPUT		PANEL HEIGHT (in inches)	REGULATION		RIPPLE RMS (max.)
	VOLTS	AMPS		LOAD	LINE	
S36-2.5	0-36	0-2.5	3½	0.01%	0.01%	1 mv
S36-5	0-36	0-5	5¼			
S36-10	0-36	0-10	7			
S36-15	0-36	0-15	7			
S60-2.5	0-60	0-2.5	5¼			
S60-5	0-60	0-5	7	0.02%	0.02%	3 mv
S60-10	0-60	0-10	10½			
S72-15	0-72	0-15	14			
S300-200	110-325	0-0.2	3½			
S300-400	110-325	0-0.4	3½			
S300-800	110-325	0-0.8	3½	0.05%	0.05%	5 mv
S300-1500	110-325	0-1.5	5¼			
T50-750	0-50	0-0.75	Bench Supply			
T20-2	0-20	0-2				
T50-1.5	0-50	0-1.5				

TRYGON ELECTRONICS, INC.
111 Pleasant Ave. Roosevelt, L. I., N. Y.
Freeport 8-2800



CIRCLE 20 ON READER-SERVICE CARD

TABLE I. Approx. Conversion Formulae—H Parameters and T Equivalent Circuit. Numerical values are typical for 2N525 at 1 ma, 5v.

SYMBOLS	COMMON EMITTER	COMMON BASE	COMMON COLLECTOR	T EQUIVALENT CIRCUIT
h_{ie}	$h_{ie} = \frac{1}{h_{fe}}$	1400 OHMS	$\frac{h_{ib}}{1+h_{fb}}$	$r_b + \frac{r_e}{1-a}$
h_{re}	$h_{re} = \frac{h_{2e} \cdot \mu_{bc}}{1+h_{fb}}$	3.37×10^{-4}	$\frac{h_{ib} h_{ob}}{1+h_{fb}} - h_{rb}$	$\frac{r_e}{(1-a)r_c}$
h_{fe}	$h_{fe} = \frac{h_{2e} \cdot \beta}{\alpha_{cb} \cdot f_e}$	44	$\frac{h_{fb}}{1+h_{fb}}$	$\frac{a}{1-a}$
h_{oe}	$h_{oe} = \frac{1}{h_{22e} \cdot Z_{22e}}$	27×10^{-6} MHOS	$\frac{h_{ob}}{1+h_{fb}}$	$\frac{1}{(1-a)r_c}$
h_{ib}	$h_{ib} = \frac{1}{h_{11e}}$	$\frac{h_{ie}}{1+h_{fb}}$	31 OHMS	$\frac{r_b}{r_c} + (1-a)r_b$
h_{rb}	$h_{rb} = \frac{h_{12e} \cdot \mu_{ec}}{1+h_{fb}}$	$\frac{h_{ie} h_{oe}}{1+h_{fb}} - h_{re}$	5×10^{-4}	$\frac{r_b}{r_c}$
h_{fb}	$h_{fb} = \frac{h_{21e} \cdot \alpha_{ce}}{\alpha_{fc}}$	$-\frac{h_{fe}}{1+h_{fb}}$	-0.978	-a
h_{ob}	$h_{ob} = \frac{1}{h_{22e} \cdot Z_{22e}}$	$\frac{h_{oe}}{1+h_{fb}}$	0.60×10^{-6} MHOS	$\frac{1}{r_c}$
h_{ic}	$h_{ic} = \frac{1}{h_{11c}}$	h_{ie}	$\frac{h_{ib}}{1+h_{fb}}$	1400 OHMS
h_{rc}	$h_{rc} = \frac{h_{12c} \cdot \mu_{bc}}{1+h_{fb}}$	$1-h_{re}$	1	$\frac{1}{1-a} \frac{r_b}{r_c}$
h_{fc}	$h_{fc} = \frac{h_{21c} \cdot \alpha_{eb}}{\alpha_{fb}}$	$-(1+h_{fb})$	$-\frac{1}{1+h_{fb}}$	$-\frac{1}{1-a}$
h_{oc}	$h_{oc} = \frac{1}{h_{22c} \cdot Z_{22c}}$	h_{oe}	$\frac{h_{ob}}{1+h_{fb}}$	$\frac{1}{(1-a)r_c}$
a	$\frac{h_{fe}}{1+h_{fb}}$	-h _{fb}	$\frac{1+h_{fb}}{h_{fb}}$	0.978
r _c	$\frac{1+h_{fb}}{h_{oe}}$	$\frac{1-h_{rb}}{h_{ob}}$	$-\frac{h_{fb}}{h_{oc}}$	1.67 MEG
r _b	$\frac{h_{ie}}{h_{oe}}$	$h_{ib} - \frac{h_{rb}}{h_{ob}}$	$\frac{1-h_{rc}}{h_{oc}}$	125 OHMS
r _e	$\frac{h_{ie}}{h_{oe} (1+h_{fb})}$	$\frac{h_{rb}}{h_{ob}}$	$\frac{h_{fb}}{h_{oc} (1-h_{rc})}$	840 OHMS

sistor analysis and are called the short circuit or conductance parameters. They are difficult to measure because the input ac or output ac circuit must be shorted for each measurement.

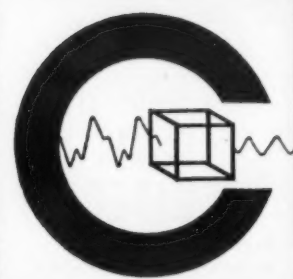
In similar fashion, if the currents are selected as the independent variables, $v_1 = f_1(i_1, i_2)$ and $v_2 = f_2(i_1, i_2)$ which results in a set of parameters called the open circuit or resistance parameters. These measurements also are difficult to accomplish accurately because the output circuit must be open circuited for ac while the dc path is maintained. At 270 cps, the frequency conventionally used to make measurements, an inductance which will achieve this result is large and cumbersome.

Hybrid Parameters

Difficulties of measurement with short circuit and open circuit parameters are avoided by the use of the so called hybrid, or mixed, parameters in which input voltage v_1 and output current i_2 are selected as the dependent variables. Input current i_1 and output voltage v_2 then become the independent variables and the general equations are:

$$v_1 = f_1(i_1, v_2) \text{ and } i_2 = f_2(i_1, v_2)$$

These equations have been developed using the



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MILITARY SYSTEMS DESIGN

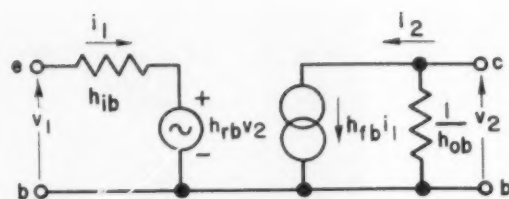


FIG. 2. EQUIVALENT Circuit Common Base Configuration.

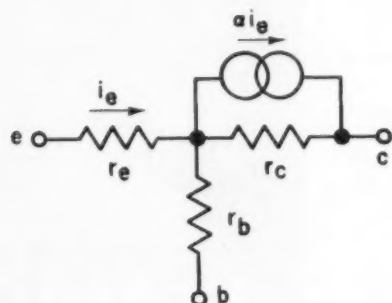


FIG. 3. "T" EQUIVALENT Circuit form is similar to transistor structure.

hybrid parameters such that

$$v_1 = h_{11}i_1 + h_{12}v_2 = h_{11}i_1 + h_rv_2 \quad (1)$$

$$i_2 = h_{21}i_1 + h_{22}v_2 = h_{fi}i_1 + h_o v_2 \quad (2)$$

where the hybrid parameters are (a) the input impedance in ohms with the output ac short circuited (expressed as h_{11} , h_i or $1/Y_{11}$); (b) the reverse voltage transfer ratio with the input ac open circuited (also called the feedback amplification factor and expressed as h_{12} , h_r , or μ_r); (c) the forward current transfer ratio with the output ac shorted (also called the forward short circuit amplification factor and expressed as h_{21} , h_f or α_f); and (4) the output admittance in mhos (also called the output conductance with input open and designated as h_{22} , h_o or $1/Z_{22}$). The forward short circuit amplification in the common emitter configuration is also sometimes designated β .

The designations used by different manufacturers and writers are equivalent to each other and are shown in the first column of Table 1 to help the reader resolve any confusion which may arise. Common practice is to use number subscripts for general circuits analysis and the letter subscripts when specifying the characteristics of transistors. In addition, the letters e , b or c are generally added to the number or letter designation of the hybrid parameter to denote whether common emitter, common base or common collector configuration is intended. As is shown in Table 1, h_{1e} is an entirely different parameter from h_{1b} or h_{1c} .

An equivalent circuit for transistors in the common base configuration is shown in Fig. 2. In this circuit the voltage transfer ratio h_{rb} appears as a voltage generator in the input circuit and the current transfer ratio h_{fb} appears as a current generator in the output circuit. The "T" equivalent circuit (Fig. 3) which approximates the actual transistor structure, is also frequently used. In this circuit r_e and r_c represent ohmic resistances of the emitter and collector junctions while

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CIRCLE 22 ON READER-SERVICE CARD

QUANTITATIVE MEASUREMENT OF RESISTOR NOISE



WITH Model 315 Resistor Noise Test Set

The QUAN-TECH Model 315 Resistor Noise Test set is a highly compact unit for making precise quantitative measurements of excess noise resulting from current through resistors.

Testing with the Model 315 is rapid—operating procedures are simple. Resistors of any type within the ohmic values specified below may be tested. Index of measurement is microvolts-per-volt in a decade of frequency, as recommended by the National Bureau of Standards.

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- Accepts any type of resistor
- Simple operation; adaptable to production line "go-no-go" use
- Single, compact, bench-size unit

In addition to the front-panel indication, outputs are available for data processing, driving go-no-go indicators, or for external monitoring.

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Range: Resistor test range 100 ohms to 22 megohms
Noise voltage 0.6 μ v in a decade to 1000 μ v in a decade
Applied DC voltage 3 to 300 volts

Filter: Flat-topped, 1000 cycle bandpass. Geometric mean at 1000 cycles

Detector: Pure RMS

Output: Indicated for both noise voltage and applied DC voltage on separate front-panel meters. Analog outputs for data processing. AC monitor jack.

Accuracy of Noise Voltage Measurement: $\pm 5\%$

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*Optional remote measuring cable, \$75.00

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TABLE 2. TRANSISTOR Circuit Equations with Hybrid Parameters.

$$\text{INPUT IMPEDANCE} \quad Z_i = \frac{v_i}{i_i} = h_i - \frac{h_f h_r Z_L}{1 + h_o Z_L} \quad (3)$$

$$\text{MATCHED INPUT IMPEDANCE}^* \quad Z_{im} = a_i [D - jC] + j b_i \quad (4)$$

$$\text{OUTPUT ADMITTANCE} \quad Y_o = \frac{i_o}{v_o} = h_o - \frac{h_f h_r}{h_i + Z_g} \quad (5)$$

$$\text{MATCHED OUTPUT ADMITTANCE}^* \quad Y_{om} = a_o [D - jC] + j b_o \quad (6)$$

$$\text{CURRENT GAIN} \quad A_i = \frac{i_o}{i_i} = \frac{h_f}{1 + h_o Z_L} \quad (7)$$

$$\text{VOLTAGE GAIN} \quad A_v = \frac{v_o}{v_i} = \frac{1}{h_r - \frac{h_i}{Z_L} \left(\frac{1 + h_o Z_L}{h_f} \right)} \quad (8)$$

$$\text{OPERATING POWER GAIN (LOW FREQUENCY ONLY, } Z_g = R_g, Z_L = R_L)$$

$$G = \frac{\text{POWER INTO LOAD}}{\text{POWER INTO TRANSISTOR}} = A_v A_i = \frac{\left(\frac{h_f}{1 + h_o R_L} \right) \left(\frac{h_i}{h_r - \frac{h_i}{R_L} \left(\frac{1 + h_o R_L}{h_f} \right)} \right)}{\frac{h_i}{R_L} \left(\frac{1 + h_o R_L}{h_f} \right)} \quad (9)$$

$$\text{MATCHED POWER GAIN}^* \quad G_m = \frac{a_i^2 + b_i^2}{a_i a_o [(1 + D)^2 + C^2]} \quad (10)$$

$$\text{MATCHED UNILATERAL POWER GAIN (} h_r = 0 \text{)} \quad G_{mu} = \frac{a_i^2 + b_i^2}{4 a_i a_o} = \frac{|h_f|^2}{4 a_i a_o} \quad (11)$$

$$Z_g = R_g + jX_g = \text{OUTPUT IMPEDANCE OF GENERATOR}$$

$$Z_L = R_L + jX_L = \text{IMPEDANCE OF LOAD}$$

* FOR MATCHED CONDITIONS

$$Z_{im} = R_g - jX_g$$

$$Z_{om} = R_L - jX_L$$

$$h_i = a_i + j b_i$$

$$h_r = a_r + j b_r$$

$$h_f = a_f + j b_f$$

$$h_o = a_o + j b_o$$

$$C = \frac{a_r b_f + b_r b_f}{Z a_i a_o}$$

$$F = \frac{a_r b_f - b_r b_f}{a_i a_o}$$

$$D = \sqrt{1 - F - C^2}$$

r_b represents the ohmic resistance between the base contact and the junctions. The current generator a_i represents the transfer of current from the emitter junction to the collector junction across the base region. Values of parameters for the "T" circuit for various configurations will be found in Table 1.

Variation of "H" Parameters with Bias Conditions

The "h" parameters are dependent on the bias conditions and when a transistor is used under conditions other than that specified for the parameter values given, those values must be corrected. Correction factors can be obtained from manufacturer's data sheets.

Once the "h" parameters are known for the particular bias conditions and configuration being used, the performance of the transistor in an amplifier circuit can be found for any value of source or load impedance. Table 2 gives the equations for determining the input and output impedance, as well as the current, voltage, and power gain of a transistor amplifier stage directly from the "h" parameters. The particular "h" parameters used in these equations must correspond to the particular circuit configuration used. For example, if it is desired to calculate the voltage gain of a common emitter amplifier stage the values h_{ie} , h_{fe} , h_{re} , h_{oe} must be used in equation 8.

With the exception of equation 9 all of the equations in Table 2 are valid at any frequency provided that the

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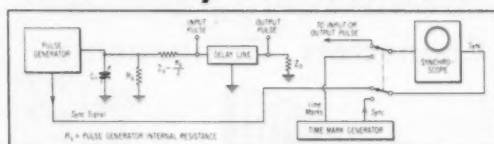
CIRCLE 25 ON READER-SERVICE CARD
January-February, 1961

values of the "h" parameters at that particular frequency are used. At the higher frequencies "h" parameters become complex and the low frequency "h" parameters are no longer valid. The matched power gain given by equation 10 requires that both the input and the output of the amplifier stage be tuned and the input and output resistances be matched to the generator and load resistance respectively. This situation is seldom met exactly in practice, but it is generally met closely enough to permit accurate results from equation 10.

If the voltage feedback ratio, h_{r_1} , is very small or is balanced out by external feedback the circuit is said to be unilateral. This means that no signal transmission can take place from the output of the circuit to the input. Under these conditions the input impedance of the circuit will be equal to h_{i_1} and the output impedance will be equal to $1/h_{o_1}$. The power gain under matched, unilateral conditions is given by equation 11. This power gain is a good figure of merit for the transistor since it is independent of circuit conditions and transistor configuration. It represents the maximum power gain that can be obtained from a transistor under conditions of absolute stability.

Note: Material in this article has been adapted in part from U.S. Army Technical Manual TM 11-690. Also, with permission of the publisher, the Semiconductor Products Department, General Electric Company, Charles Bldg, Liverpool, N. Y., portions of the *General Electric Transistor Manual*, Fifth Edition (329 pages, \$1.00), have been used.

Time Delay Measurements



The test circuit shown can now be used for all time delay measurements within the range of sweep speeds available on the synchroscope. The pulse generator should produce a rectangular pulse with a maximum rise time of 0.02 μ sec. Measurements are made as follows:

1. Adjust the output time of the pulse generator with C.
2. Calibrate the desired sweep of the synchroscope with the time mark generator.
3. View the input pulse to the delay line.
 - a. Adjust the vertical amplitude to an exact number of divisions on the screen.
 - b. Set the 50% amplitude point of the rising portion of the pulse at an exact vertical division.
4. Without changing the sync pulses, view the output pulse of the delay line.
 - a. Adjust the output pulse amplitude as in 3a.
 - b. The time delay is measured as the distance between the 50% points of the rising portions of the input pulse and output pulse. This distance is calibrated in μ sec/cm.

The use of a dual-trace oscilloscope will allow time marks to appear on the screen at the same time the input or output pulse is being viewed. Or, if the sweep speed of the scope is pre-calibrated, the input and output pulses may be viewed simultaneously, and a delay time reading can be taken immediately . . . (From 12-page Bulletin 192, Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., 50 Avenue L, Newark, N. J.)

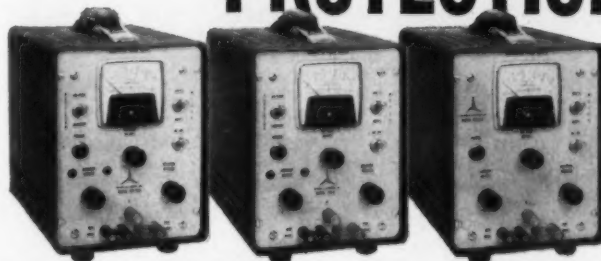
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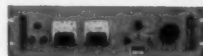
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0-2A
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CONSTANT CURRENT

T50-1.5

0-50V,
0-1.5A
CONSTANT VOLTAGE

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Regulation	0.05% or 15 mv		
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Remote Programming	50 ohms/volt over entire range		
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Ripple	0.01% or 25 microamps		
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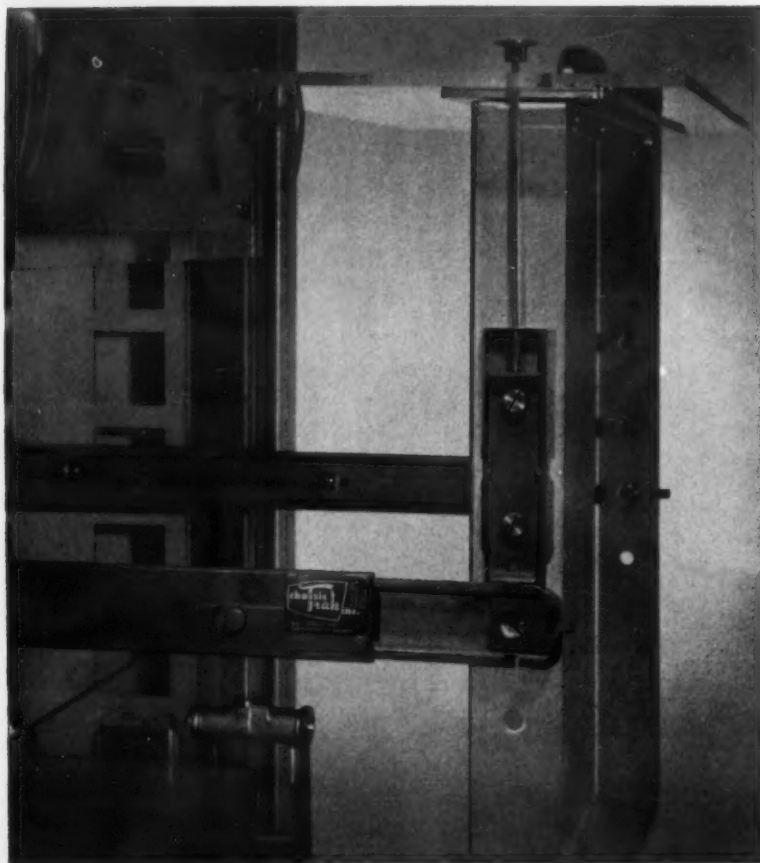
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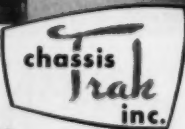
Model C-300 Detent locks in three service positions —
90° up, horizontal, 90° down

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Model C-300 Detent slide shown locked in horizontal position.



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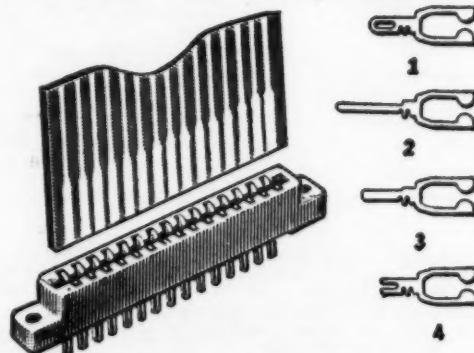
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FOR THIS LITERATURE CIRCLE 122 ON READER-SERVICE CARD

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Infrared Eyes of TIROS II

Three infrared devices produced by the Barnes Engineering Company, Stamford, Conn., are assisting the "weather satellite," TIROS II, in its cloud reporting. Because the TIROS II is space-oriented like a gyroscope, its axis points toward Earth only a part of each of its orbits. During more than half of each orbit its cameras point into empty space.

One infrared device, the horizon scanner, helps establish a line of reference so that monitoring scientists can turn the cameras off to conserve the power supply when the Earth is not being viewed. This device senses the sharp discontinuity at the Earth's horizon between thermal self-emission from the earth and cold space to establish the local vertical, a line aimed at the center of the Earth. Any deviation from this vertical is measured by the horizon sensor and telemetered to the ground for interpretation.

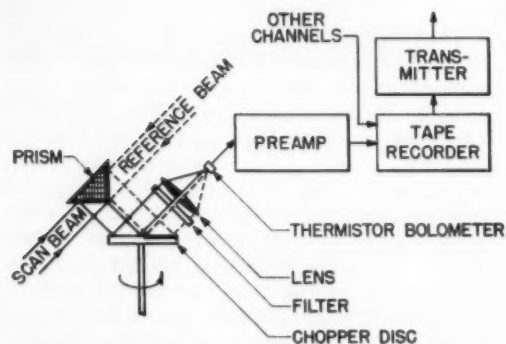


FIG. 1. ALTERNATE VIEWING of Earth and empty space by thermistor bolometer provides comparison of changing earth temperature against constant temperature of outer space. One channel of Barnes 5-channel infrared radiometer is shown.

A second device is a 5-channel radiometer which looks out alternately in two opposite directions. Using five separate detectors to measure infrared radiation in five different wavelength ranges (Table 1), each detector is alternately exposed to reflections from the Earth and from outer space. Outer space temperature is constant and serves to provide a reference for the Earth's radiation. The method for alternate viewing is shown in Fig. 1. Infrared radiation plus visible light enters each channel of the radiometer head from each side. Both beams are reflected 90° by a prism, to fall on a rotating disc, which is a mirror with one half its surface coated with infrared absorptive paint. As the mirror turns the incoming beams are alternatively chopped and reflected, thus creating an ac signal when they fall on the thermistor bolometer. This signal is amplified, rectified and stored on magnetic tape to be played back on command from the monitor stations.

A third infrared device is an "albedo meter". Albedo is a meteorological term indicating reflective efficiency. In this case, the ratio between solar energy reflected from the Earth to the total energy received by the planet is measured.

- improved performance and characteristics
- decreased size, weight and power consumption
- functional replacements for Military types TD97 and TD98



New ALL-TRANSISTOR MULTIPLEXER and DEMULTIPLEXER

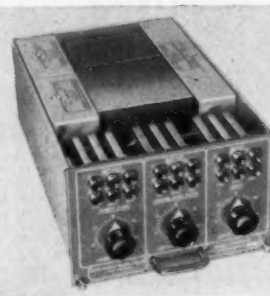
Type 248 Model 1 Type 249 Model 1

The new Multiplexer, Type 248 Model 1 (functional replacement for Multiplexer TD97-FTG-2), and Demultiplexer, Type 249 Model 1 (functional replacement for Demultiplexer TD98-FGR-3) are intended for use with twin-channel, single-sideband radio circuits operating in the high-frequency range. Their purpose is to derive two voice-frequency circuits from each of the radio channels. By means of frequency division multiplexing, the radio bandwidth from 200 to 6000 cps is divided into two transmission circuits, each with a bandwidth from 375 to 3025 cps. Four such vf circuits are derived from the twin-channel radio, and these are used to transmit carrier telegraph signals or to provide telephone or facsimile service.

The Multiplexer and Demultiplexer are designed to slide into the Northern Radio Type 250 Model 1 Shelf, which accommodates two each Multiplexers or Demultiplexers, or one each Multiplexer and Demultiplexer.



Two Multiplexers, Type 248 Model 1, are required for full utilization of the capacity of a radio transmitter. One is used to transmit telegraph, telephone, or facsimile signals from two vf circuits to the radio channel designated as sideband A. The second Multiplexer performs the same function for sideband B. In this way four vf circuits are applied to the twin-channel radio transmitter.



Two Demultiplexers, Type 249 Model 1, are required for full utilization of the capacity of a radio receiver. One is used to receive telegraph, telephone, or facsimile signals for two vf circuits from the radio channel designated as sideband A. The second Demultiplexer performs the same function for sideband B. In this way four vf circuits are derived from the twin-channel radio receiver.



The Multiplexer and Demultiplexer are transistorized equipments, including necessary bandpass filters, line amplifiers, carrier frequency sources, modulators and attenuators. The Multiplexer requires a nominal 14 volts DC at 125 milliamperes; the Demultiplexer, approximately 200 milliamperes at the same voltage. The power supply is normally provided from the Northern Radio Power Supply, Type 223 Model 1, which is plugged into the rear of the Type 250 Model 1 Shelf.

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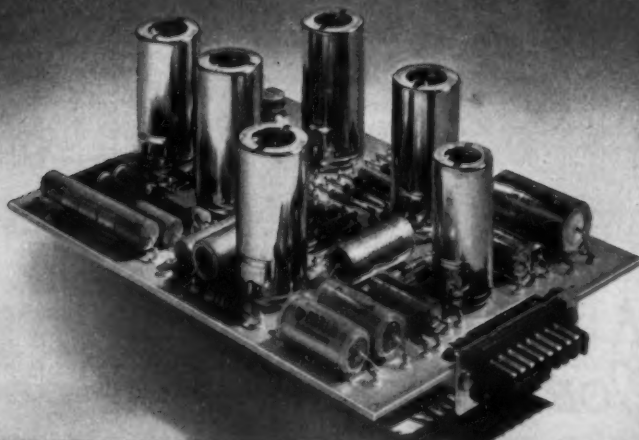
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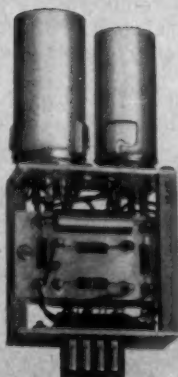
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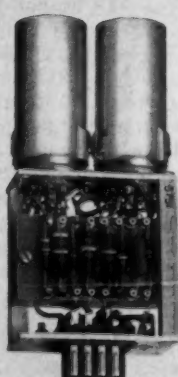


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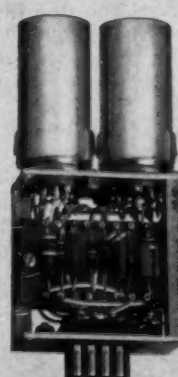
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K2-WJ An efficient, fool-proof, high gain, low cost operational amplifier for all feedback manipulations. Its differential inputs allow use either as a "follower" or as a positive sign amplifier featuring "infinite impedance" input (open grid). The guaranteed minimum gain figure of 10,000 (over 15,000 typical), ± 50 volt output, and the low drift make possible a wide variety of dc and low frequency operations such as summing, amplification, function generation, integration, differentiation, voltage clipping, tripping, flipping, flopping, and the like at accuracies substantially better than 1/10%. Price (1 thru 99).....**\$58**



K2-YJ An operational amplifier identical in shape, size, and concept to the K2-WJ, but featuring twice the output voltage (± 100 v) and three times the output current (3 ma) at a sacrifice in gain. Most characteristics are also similar, including drift. Using the K2-PJ as a preamplifier for the K2-YJ, the pair becomes the coolest-running, most compact operational amplifier available which can provide ± 100 volts output, chopper stabilized. Price (1 thru 99).....**\$62**

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continued from page 23

TABLE 1. CHANNEL WAVELENGTHS and Functions of 5-channel Scanning Radiometer

Channel	Wavelength range, in microns	Function
1	6.3 \pm 10%	Strong water vapor emission. Yields temperature near middle of Earth's atmosphere.
2	0.55 to 0.75	Visible range. Detects nature of cloud cover in the daytime. Response close to that of human eye, and serves as reference for infrared channels.
3	0.2 to 5.5	About 99 per cent of solar radiation falls into this band. Channel measures albedo of the Earth (energy from the sun striking the Earth, but not absorbed).
4	7.5 to 30.0	Measures Earth's total emission, i.e. temperature of Earth as viewed from the satellite.
5	7.5 to 12.0	Atmospheric window. Measures temperature of the Earth or its cloud cover. Looks through atmosphere in area where water vapor absorption and emission are low.

The albedo meter is a two-channel radiometer having two collecting lenses which resemble thin plastic cones coated with aluminum on one side, gold on the other. (Fig. 2). One cone focuses on a white thermistor flake, which reflects visible light but absorbs infrared radiation. This reads a value proportional to the Earth's temperature. At the focus of the second cone a black thermistor absorbs all radiation, which is a measure of the reflectivity of the Earth or albedo. Thus the 2-channel radiometer reports on Earth temperature and albedo whenever it is pointed toward the Earth.

The two-channel radiometer weighs only 1 1/2 oz. and requires only 50 microwatts to operate. The platinum detector wires are only .0005" in diameter which must be soldered under a microscope and with very steady hands. This radiometer was added to an already full payload, which was the reason it had to be practically weightless. More weight would have meant the TIROS II would be too heavy to place in orbit with the Thor-Delta launching vehicle.

FIG. 2. ALBEDO METER weighing only 1 1/2-oz was added to already full payload to provide a measure of Earth's reflectivity.



FOR MORE INFORMATION CIRCLE 123 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

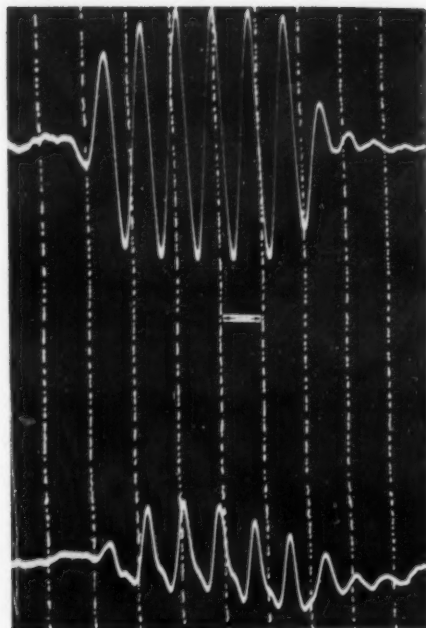


FIG. 1. TIME PULSES from 5000-mile distant transmitter are compared on oscillograph unit pulse from local clock. Vertical markers are spaced 1 μ sec apart.

The deep concern of the U. S. Navy in the precise determination of time and frequency dates from the establishment of the Naval Observatory in the early 1830's as the official time determining agency for the U. S. The first radio time signal was transmitted in 1904, with regular time broadcasts from NAA Arlington, Va., beginning in 1913.

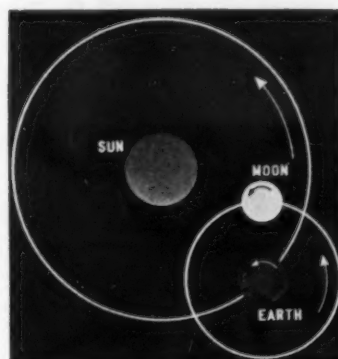
Today time pulses of one-microsecond duration are used in radar, in precision navigation systems, for velocity measurement and guidance of fast-moving aircraft and missiles, and in the rating of ship and shore frequency standards. Microsecond synchronization of clocks for periods of 24 hours or more at a number of range stations is desirable for accurate determination of the velocity of a missile along its trajectory or for the timing of a satellite in its orbit. This means that the standard frequency oscillators used to control the clocks at the various remote points must not vary by more than one cycle in one hundred billion (1 part in 10^{11}) per day.

Similarly, accurate synchronization of frequency standards to a minimum allowable accuracy of 1 part per 10^7 in suppressed carrier-type single-sideband transmitters and receivers requires that the secondary standard used in each installation must not deviate from that at any other ship or shore station by more than 1 part per 10^8 over a period of 60 days. This requirement assumes that each station will check and correct its reference oscillator at least once every 60 days against a reference standard having world-wide availability and that the individual standard oscillators will not drift at an average rate of much more than 1.5 parts per 10^{10} per day. At the present, the AN/URQ (8,9,10) 5-Mc precision oscillator meets this requirement. Extraterrestrial and space navigation,

Precision Frequency Control and Millisecond Timing

by H. F. Hastings, U. S. Naval Research Lab. Washington, D. C.

FIG. 2. ORBITAL periods of earth about sun and of moon about earth provide basis for the second of Ephemeris Time (ET). Earth's rotation, the basis for the Universal Time second (UT-2) has small seasonal variations, also is constantly slowing down.



among other requirements, will necessitate continuing refinement of existing techniques, and new atomic precision frequency sources are being developed for these applications as well as for the primary standard at NRL.

Long-Distance Frequency Synchronization

In one microsecond, radio signals travel a little less than 1000 feet. If either the transmitter or receiver is moving, or if the path of the wave varies from moment to moment due to shifts in the reflecting ionospheric layers, doppler shift of the signal frequency will occur. Where a difference of 0.1 millisecond can be observed in 24 hours, frequency can be checked to 1 part in 10^9 per day (Fig. 1). Greater accuracy can be achieved by measurements over a longer period, or by increasing the capability of observing smaller time changes.

Time pulses in the 2-30-Mc band can be received to a resolution of 0.1 millisecond over a path as long as 5000 miles. Very low frequency (VLF) radio waves (below 30 kc) are more dependable as long-distance time-signal broadcasts. Phase comparison of received VLF signals is more rapid than time-pulse measurements, and 15 minutes is sufficient to determine frequency correct to 1 part/ 10^9 , and in three hours to 1 part in 10^{10} . The phase-change method permits a difference of 1 microsecond to be observed, whereas pulse-starting time cannot be observed more accurately than 0.1 millisecond.

Special time-measuring equipment, developed at NRL by Bey and Hastings and offered for commercial sale by at least one manufacturer, is necessary for accurate determination of time of day. For highest accuracy, it is also necessary to correct the apparent time to include signal delay introduced by propagation from transmitter to receiver, using correction data



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for the particular location as obtained from U. S. Naval Observatory Bulletins.

Atomic Frequency Standards

The motion of the earth about the sun and the orbital motion of the moon about the earth provide the basis for the Ephemeris Time (ET) second (Fig. 2). This unit is more unvarying than the UT-2 second, the fractional part of the daily rotation of the earth, which varies with the season and also lengthens as the rotation of the earth slows down. A new clock based on the atomic response of cesium vapor and known as the Atomichron is being used at NRL as a reference standard. This is compared via VLF broadcasts between NBA (Balboa, C. Z.) and GBR (Rugby, Eng.) with a cesium-beam resonator at the National Physical Laboratory at Teddington, England. The U. S. Navy and British VLF stations are maintained on constant frequency and synchronized time with each other. If

corrections are needed, the Naval Observatory and Greenwich Observatory consult and make simultaneous corrections.

An instrument for accurate comparison of the phase of 2.5 Mc and 5 Mc carriers has also been provided to the observatory for monitoring the phase of station WWV or similar transmissions. This is accurate only up to 20 miles because of multipath and doppler shift effects at greater distances.

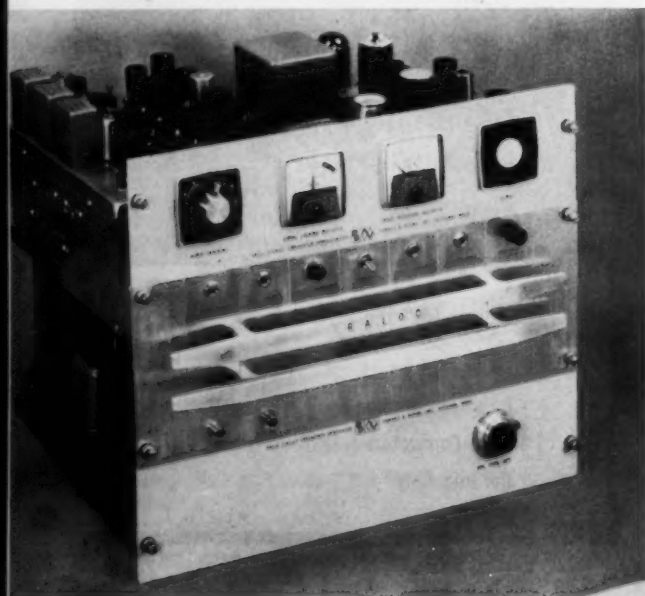
As necessary VLF equipment becomes available and is installed, four other U. S. Navy VLF stations will begin operation to provide coverage of the world with a constant frequency carrier in the 15-25 kc band. This utilization of the carrier does not impair the communication capability of the stations, thus providing the most economical use of the limited facilities of the VLF spectrum.

Condensed from an article of the same title published in NAVAL RESEARCH REVIEWS, September 1960.

Equipment For Precise Timing and Frequency Control

Equipment available for implementing the precise frequency techniques described in the article by Mr. H. F. Hastings in this issue, is briefly reviewed below.

FIG. 1. PRECISE TIME and Frequency Calibrator, RALOC, can be operated to give continuous comparison with incoming standard or as an oscillator locked in phase and frequency to the incoming signal.



Locked Oscillator Synchronizing System

The RALOC Precise Time and Frequency Calibrator, developed and manufactured by Pickard & Burns, Inc., 240 Highland Avenue, Needham 94, Mass. (Fig. 1), can be used as: (1) A frequency phase comparator, (2) as an automatic frequency synchronizer and (3) as an independent secondary frequency standard. The block diagram of the RALOC is shown in Fig. 2.

When used to compare a received VLF radio signal with the station standard oscillator, the radio signal, say at 18 kc, is received on a narrow-band TRF receiver which feeds the amplified signal to two quadrature, coherent phase detectors: A servo-locking phase detector (#1), and a signal-locking indicator phase detector (#2). A signal on-off circuit ensures that the servo amplifier will be shut off when there is no signal, even in the presence of noise.

From an external local standard 100 kc oscillator, which may be an AM/URQ-(8, 9 or 10) type oscillator, 18 kc is derived and fed through a phase shifter to the two quadrature phase detectors. The phase shifter is rotated by the servo systems until the 18 kc signal provided to phase detector #1 is 90° away in phase from the received signal. The servo loop consists of phase detector #1, signal on-off switch, servo amplifier, servo motor, the

phase shifter and the generated 18 kc signal. Phase detector #2 has a maximum output when phase detector #1 is locked, giving a positive indication on the Signal Locking indicator. The oscilloscope presents an elliptical Lissajous pattern which will appear with the code signals from the VLF station.

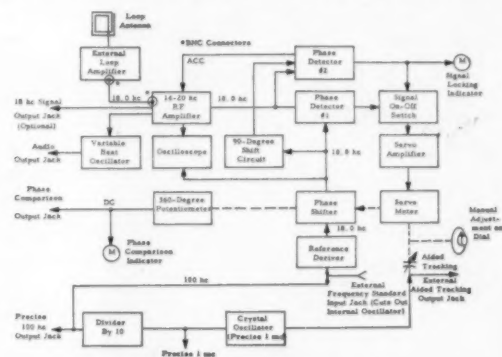


FIG. 2. RALOC System, Block Diagram.

The rotation of the phase shifter provides a 0°—360° phase comparison dc output. This output is fed to the Signal Locking indicator and can also drive a standard 0-1 ma chart recorder from the phase recorder jack.

When operated locked to the incoming signal to automatically control the frequency of a local secondary frequency standard, a suitable variable "aided-tracking" capacitor is placed in the frequency-determining circuit of the local standard oscillator. The setting of this capacitor is adjusted by the servo system. Therefore, when a frequency difference exists between the received 18 kc primary signal and the signal derived from the local standard, the servo system automatically corrects the oscillator frequency to reduce the phase difference to zero. Long time constants in the servo loop average out small phase flutters. Also the gear train during the "Aided-Tracking" capacitor has a time constant of more than an hour, which very slowly changes the frequency, integrating out any rapid changes caused by propagation vagaries.

When operated without an external oscillator, but with its own built-in crystal oscillator, RALOC becomes a secondary standard with precise 1 mc and 100 kc outputs stabilized by the remote VLF signal.

Time and Frequency Comparison Equipment

A precision time measuring system specifically designed to the requirements of the Bey-Hastings time measuring system is the Hewlett-Packard combination shown in Fig. 3 consisting of their Model 120AR Oscilloscope, 114AR Time Comparator, 103 AR Quartz Oscillator, 113 AR Frequency divider and clock and 724AR Standby Power Supply. All are on standard rack-mounting panels. The Hewlett-Packard Co. is located at 1501 Page Mill Rd., Palo Alto, Calif.

The time difference between the once per-second WWV standard time signal and the tick output from the Hewlett-Packard 113AR can be resolved

to 10 microseconds under conditions of noise-free time signal reception; The data thus accumulated by comparisons with VLF or HF time signals over a period of minutes, days, weeks or months may be used to determine the long-term drift of the stable

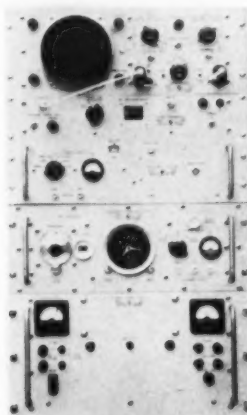


FIG. 3. TIME AND FREQUENCY Comparison system designed by Hewlett-Packard for operation with Bey-Hastings time measuring system.

frequency source or for time checks in Time Standard Systems.

If the Frequency or Time Standard is to be used in a fixed location and time comparisons are to be made against Standard Time Signals from only one station, time differences may be measured accurately and rapidly by use of the 1113AR calibrated phase shifter and the 120 AR Oscilloscope. On the other hand, operation in seagoing vessels or other vehicles requires time corrections to ac-



FIG. 4. VLF RECEIVER, Model 500 Instrument Co. of Florida, has five pre-set and pretuned frequency channels in the 14-30 kc range.

count for variations in propagation time due to movement of the system. In such cases, addition of the 114AR Time Comparator simplifies operation and increases efficiency.

The 103 Quartz oscillator, 113AR Frequency Divider and Clock operate from 24 v dc. The 724AR Standby Power Supply is designed for supplying power from standby batteries to the 113AR and the 103AR Frequency Standard over extended periods of local power failure.

January-February, 1961

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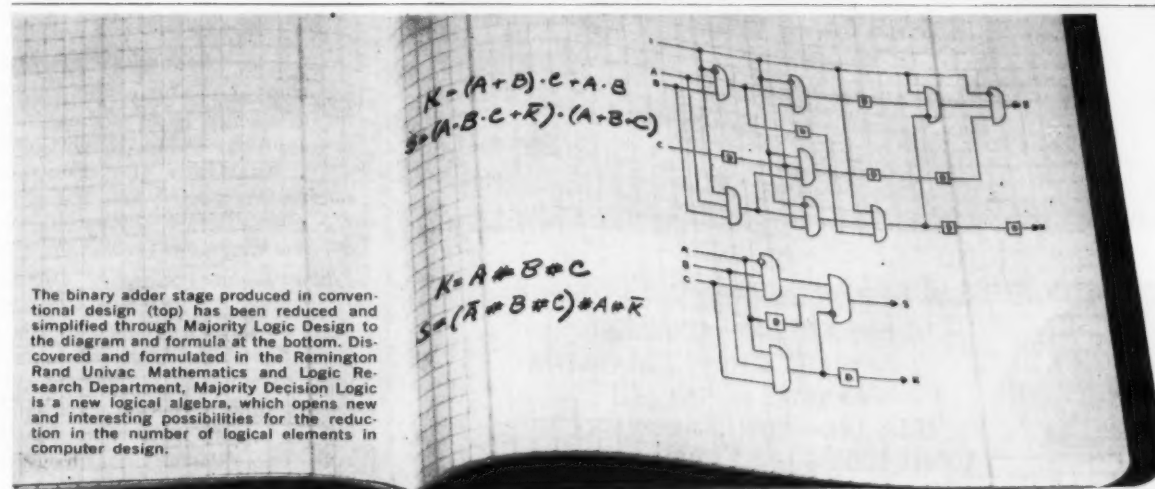


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VLF Receiver

The time and frequency comparison systems described above have depended on a separate VLF or HF receiver. One VLF receiver available for this use is the Model R500, a product of the Instrument Corporation of Florida, 4th & C Sts., Melbourne, Fla., shown in Fig. 4. This is a pre-tuned unit adjusted to receive signals from five stations operating in the 14-30 kc band, including GBR and NBA. For time measurement the output is heterodyned against a internal precision-controlled oscillator which is offset from the received signal by 1000 cycles. The resultant 1000 cps beat, after filtering may be displayed on an oscilloscope, recorded on magnetic tape, or used to synchronize a time clock by usual techniques. An output is also provided for phase measurements using a ultra-stable local oscillator. This output is intended to operate a precision phase detector and recorder, furnished separately.

Time Code Generator

A complete precision timing system for furnishing time code signals to a Missile Range System, designed by Hermes Electronics, Cambridge, Mass., for the Vandenberg AFMB, was described in detail in the March-April, 1960 issue of MILITARY SYSTEMS DESIGN. This system, which uses the phase comparison method to accurately set its master oscillator to the time of day is shown in Fig. 5. It also provides a variety of time codes for use by range instruments on the missile range.

Secondary Frequency

A typical secondary standard for use on ships or at detached bases is the AN/URQ-10, (Fig. 6) developed by Collins Radio Company, Cedar Rapids, Iowa. Other similar equipment (including models AN/URQ-8 and 9) is being produced by the George Borg Co., Janesville, Wisc., and western Electric Co., New York, N. Y.

The Radio Frequency Oscillator AN/URQ-10 is designed to generate three highly stable and accurate radio frequency signals (Fig. 7). A temperature-stabilized, crystal-controlled oscillator is used to generate a five-megacycle signal that is used both as an output signal and as an input signal for a one-megacycle, frequency-divider circuit. This divider circuit converts the five-megacycle signal to a one-megacycle signal, which is used both as an output signal and as an input to a 100-Kilocycle, frequency-divider circuit. The output of this circuit, a 100-kilocycle signal, is a result of converting the one-megacycle signal and is used as the third output signal from the radio frequency oscillator.

FIG. 6. SECONDARY FREQUENCY STANDARD AN/URQ-10 is typical of crystal-controlled stable oscillators used for Station and shipboard frequency control. When corrected against VLF or other reliable transmissions once in 60 days these standards should not vary more than 1.5 parts/10¹⁰/day.

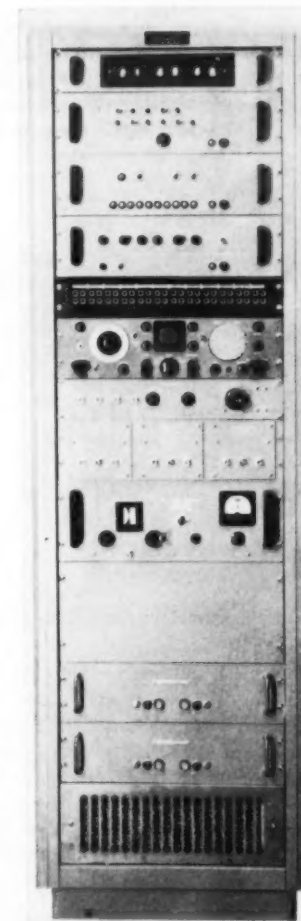
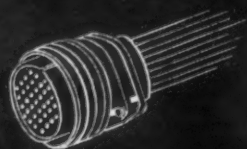


FIG. 5. TIME CODE GENERATION for synchronization of missile-range data-gathering instruments is function of Hermes Electronics System, which operates from a master clock corrected from standard time signals.



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CIRCLE 34 ON READER-SERVICE CARD

January-February, 1961

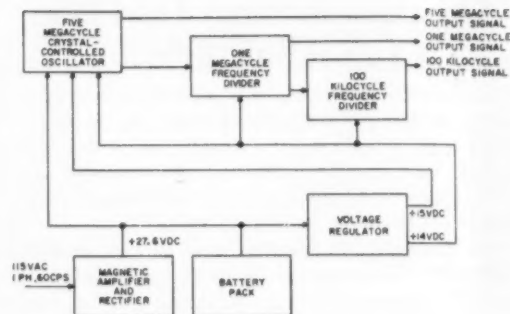


FIG. 7. AN/URQ-10 BLOCK DIAGRAM

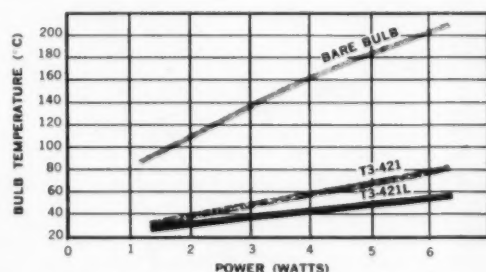
Power to operate the radio frequency oscillator is obtained from an external source at a level of 105 to 125 volts, 50 to 60 cps. This input power is converted to the correct dc voltages for operating the circuits of the radio frequency oscillators by transformer, magnetic-amplifier, rectifier and voltage-regulator action. These same power circuits are used to maintain a standby battery pack in a charged condition. This battery pack automatically provides power input to the radio frequency oscillator circuits whenever external power is removed, and can maintain normal operation up to two hours.

Except for the magnetic amplifier in the power supply circuit, all circuits in the radio frequency oscillator are transistorized.

FOR MORE INFORMATION ON PRODUCTS CIRCLE NUMBERS AFTER COMPANY NAMES: PICKARD & BURNS (124), HEWLETT-PACKARD (125), INST. CO. OF FLORIDA (126), HERMES ELECTRONICS (127)

Shield Effects on Tube Temp

IERC's horizontal mounted shields increase tube life by reducing the bulb and element operating temperatures as shown. Note that the ambient temperature in the figure is 25°C and the bulb temperature will increase degree for degree with an ambient tem-

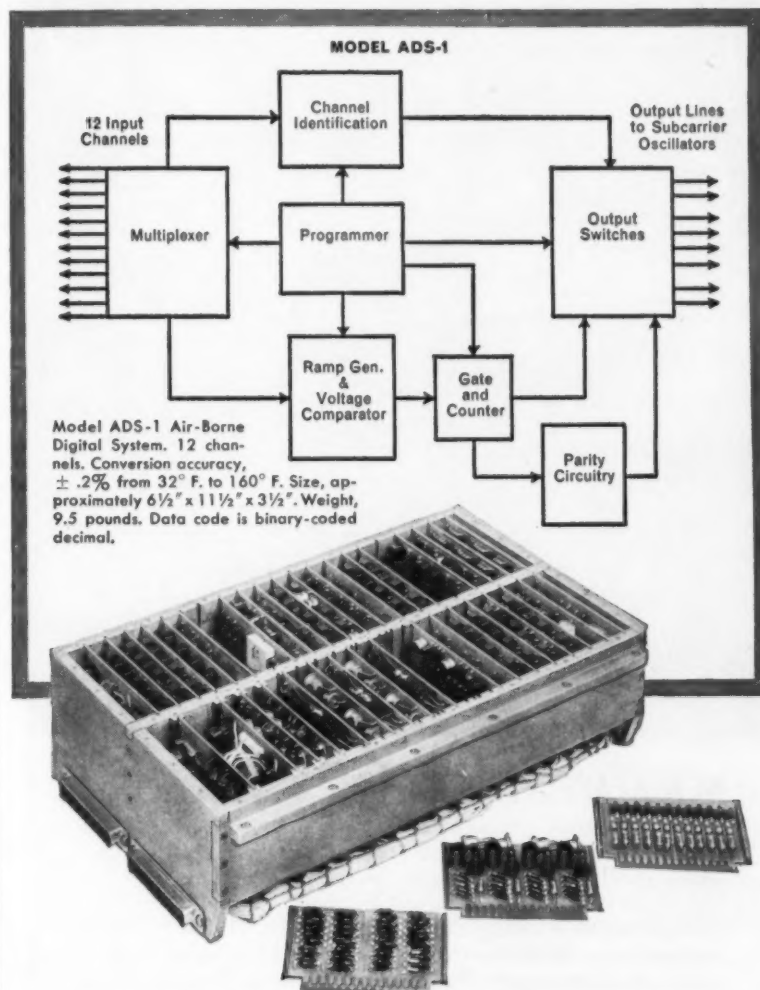


perature increase. It is only necessary to correlate the tube life with the temperature reductions in the figure to realize the tremendous tube life increase afforded by IERC's horizontal shield. The full and intimate contact with the glass bulb surface eliminates the temperature gradients along the bulb surface . . . (From 24-page catalog, IERC Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.)

FOR THIS LITERATURE CIRCLE 128 ON READER-SERVICE CARD



DIGITAL DATA SYSTEMS



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Typical of Curtiss-Wright digital systems is Model ADS-1, designed primarily for missile use. It converts multiplexed analog voltages to a digital equivalent for use with FM-FM Telemetry Systems, magnetic or paper tape recorders. System includes input multiplexing, an analog to digital converter, output switching, channel identification and parity checking. Composed entirely of solid state components, except for 12 electromechanical input switching relays. Ideal also for ground instrumentation, industrial quality control, development laboratories. Special systems custom-designed to meet your specific requirements. Blueprint your problem and let us suggest an answer.

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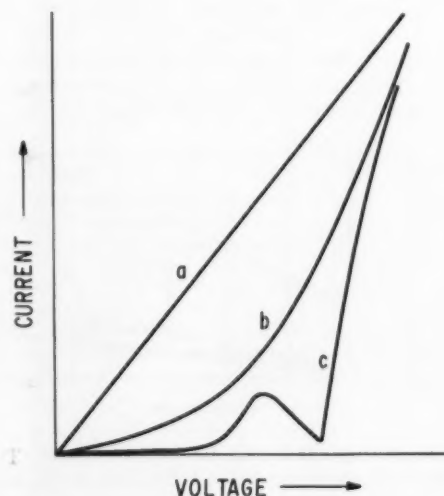
Little Falls, New Jersey
CIRCLE 36 ON READER-SERVICE CARD

Superconducting Thin-Film Tunneling Effect

A discovery that yields new scientific concepts may make possible a new family of electronic devices . . . in an entirely new way—a simple device that could function as a switch, diode, negative-resistance diode, triode, resistor or capacitor, reports General Electric Research Laboratory, Schenectady, N. Y.

The tunneling of electrons through thin insulating layers can be understood by thinking of the charge-carrying electrons not as particles, but as waves. When these charge-carrying waves strike a barrier (such as would be imposed by an insulator), virtually all of them will be reflected back from the barrier. There is a certain small probability, however, that a portion of the waves will pass through the barrier if it is thin enough. If a conductor is present on the other side, the presence of these "tunneling" waves may be detected as current. Despite the small probability of waves "tunneling" rather than reflecting, the number of the waves is so large that a substantial current may flow because of the effect.

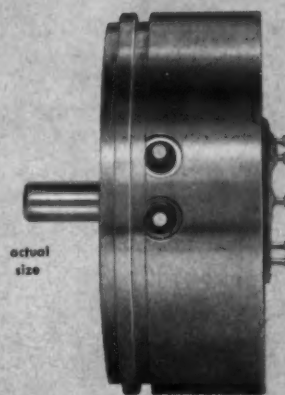
Certain conditions must prevail for electron tunneling to be significant. If two plates of metal are separated by a good insulator, they form a capacitor. Current does not flow through the insulator, even if it is as thin as one ten-thousandth of an inch. However, if the insulator is made even thinner, say from 10 to 100 atoms thick, the probability of electrons getting through the barrier becomes sufficient for a measurable current to flow. At relatively low voltages, the current induced by tunneling is proportional to the voltage, just as it would be if the insulator were an ordinary resistance element. That is, as higher voltages are applied, the current increases.



Current-voltage characteristics for tunneling through a thin insulating film

- (a) Tunneling between two normal metals.
- (b) Tunneling between one normal metal and a superconductor.
- (c) Tunneling between two superconductors, showing negative resistance.

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MILITARY SYSTEMS DESIGN

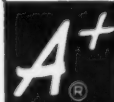
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CIRCLE 39 ON READER-SERVICE CARD

January-February, 1961

In experimenting with tunneling through ultra-thin insulating films, Ivar Giaever of the GE Research Laboratory found an unexpected effect when one of the conducting films was a superconductor. Instead of a straight line graph showing that the current increased proportionally with the voltage, an S-curve was produced, indicating that an effect similar to that in the tunnel diode might be involved. Giaever quickly followed up this lead and found that a region of "negative resistance"—in which the current decreases with increasing voltage—could be observed if both metal films were superconducting . . .

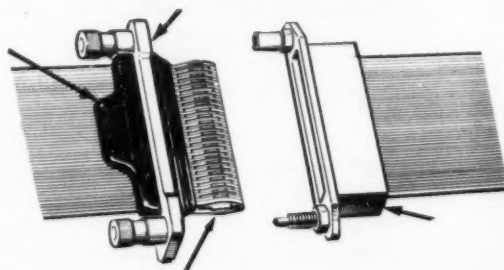
This unpredicted finding has important implications for theories about superconductivity and about tunneling. From the practical standpoint, the discovery may become important by making possible a new family of devices unequalled for their small size, and versatility.

Most of Giaever's experiments have been with films of aluminum, lead, indium and tin, all of which become superconductive at near liquid helium temperatures. A considerable number of other metals are expected to exhibit the same effect. In almost all the experiments, aluminum oxide was the insulating layer, although Giaever has obtained proof of tunneling through tantalum oxide, niobium oxide and nickel oxide as well.

One of the primary advantages of any device incorporating the effect discovered by Giaever is the possibility of changing the device's characteristics with a magnetic field . . . Other potential advantages of devices based on the new effect would be extremely small size, low power requirements, and cheapness of fabrication.

FOR MORE INFORMATION CIRCLE 129 ON READER-SERVICE CARD

Flat Conductor Cable Connectors



T&B Research Engineers were asked, in connection with a specific missile application, to solve a problem with a new wiring concept—Flat Conductor Cable. The application involved 2", 25-conductor cable on 0.075" centers. The problem was inter-connecting this cable more efficiently than existing methods . . . The illustrated precision connector solves the problem by utilizing individual Beryllium copper springs with 200-gram contact pressure to mate with an outer shell containing either printed circuit board or a second length of cable. There is no intermediate joint to increase resistance or reduce reliability . . . (From 4-page bulletin, Thomas & Betts Co., Inc., Elizabeth, N. J.)

FOR THIS LITERATURE CIRCLE 130 ON READER-SERVICE CARD



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Rated Speed (rpm)	3600	5000
Linearity (% to 3600 rpm)	.07	.1
Winding Resistance (ohms)	125	
Output Impedance (ohms)	—	36
Ripple Voltage	2% above 100 rpm	2.5% at 3600 rpm

TYPICAL MECHANICAL DATA

Friction Torque (in. oz.)	0.25	0.25
Rotor Moment of Inertia (gm-cm ²)	7	8
Weight (oz.)	5.5	5

Write for complete data



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CIRCLE 41 ON READER-SERVICE CARD

Piezoelectric Crystals Stabilized By Pressure

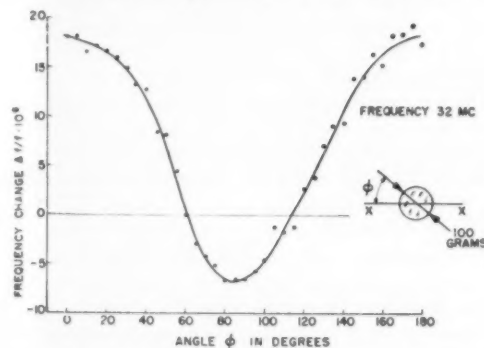


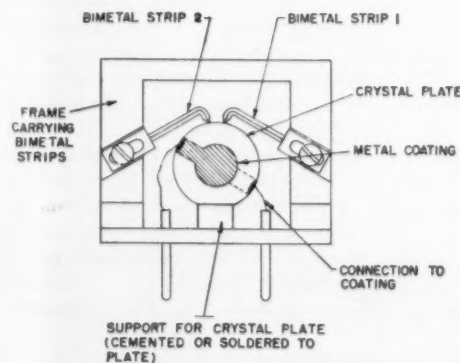
FIG. 1. INFLUENCE of the direction of pressure on frequency of a 32-mc AT crystal resonator.

The temperature-control oven of a communications frequency-control crystal is difficult to miniaturize. Crystal ovens also require considerable power. An alternative method of stabilization which requires no oven nor heating power has been developed by the U. S. Army Signal Corps Laboratories at Ft. Monmouth, N. J., who state that a contract to manufacture the device may be initiated in May 1961 or later.

The new method¹ is based on the sensitivity of thickness-shear quartz crystal resonators to external pressure. Fig. 1 shows the influence of 100 grams on the frequency of a 3rd overtone AT quartz crystal resonator plotted as the function of the orientation of such stress to the crystallographic X-axis. Note that the observed frequency change can be either positive or negative, depending on the orientation of the stress. Also, the frequency change for one particular stress orientation is always proportional to the amount of stress. If the stress is made temperature dependent and applied to selected spots at the circumference of the crystal plate, the frequency-temperature behavior of the plate can be modified.

Compensation both above and below ambients can be used to cover a wide range, as shown in the dual bi-metal strip device in Fig. 2. In this device, strip #1

FIG. 2. CRYSTAL UNIT with two bimetal compensating strips.



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CIRCLE 44 ON READER-SERVICE CARD

January-February, 1961

starts to touch the crystal at a temperature of 43°C and, as the temperature increases, exerts an increasing pressure. This causes the frequency to shift. Strip #2 is arranged so that its pressure begins to be exerted at 0°C and increases as the temperature falls. This corrects down to approximately -20°C. The proper pressure points to accomplish positive or negative correction with increasing pressure may be selected by referring to the curve of Fig. 1.

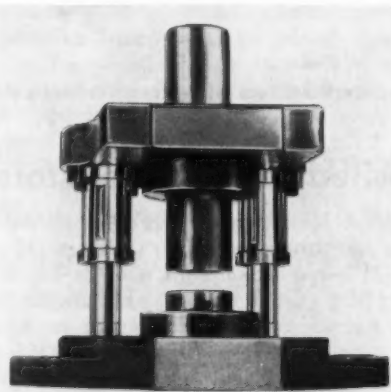
Aging of crystals should be greatly reduced by using the pressure system of compensation because the crystals will operate at a much lower average temperature.

¹ Excerpted from *Proceedings of the IRE*, Vol. 48 No. 2, Feb. 1960.

Die-Set Ball Bushing

Interchangeable with standard plain bronze or steel bushings in existing dies, the new Die-Set Ball Bushings allow closer fits and maintain alignment, increasing die life and performance, permitting longer uninterrupted runs, and reducing toolroom cost. Periodic lubrication is eliminated; higher speeds fewer sharpenings, and sustained parts accuracy are possible. Unlimited travel permits die to be used in any press regardless of stroke.

The punch holder "floats" on and off, eliminating



DIE-SET with Ball Bushings
Installed.

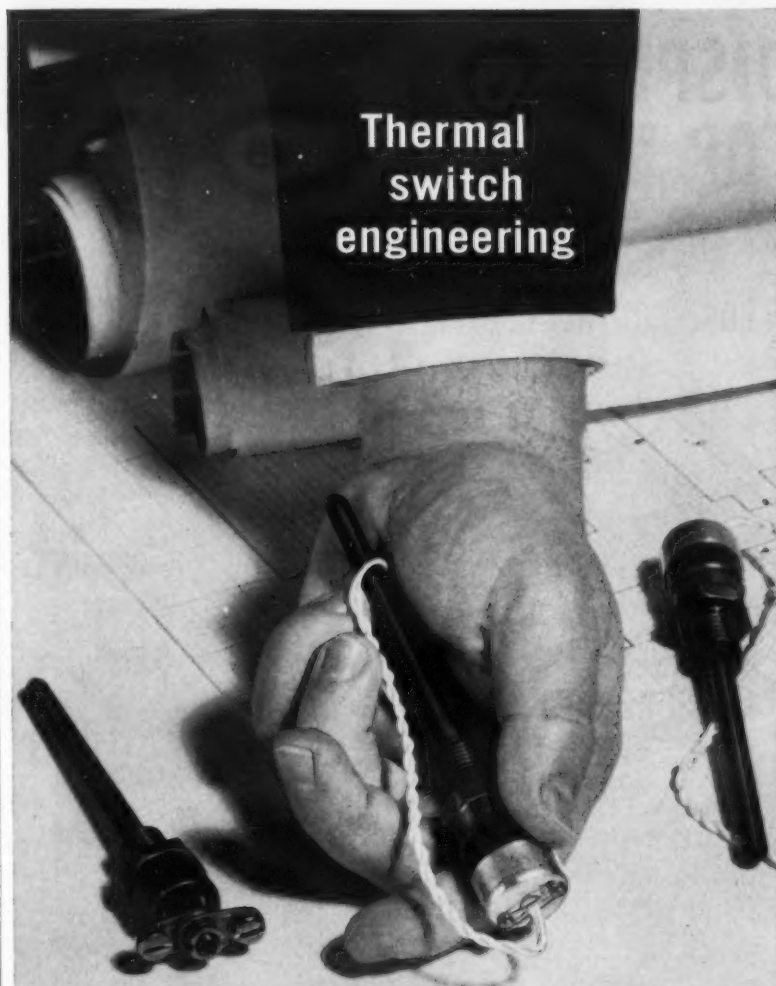


DIE-SET Ball Bushing.

die jacking. Free rolling ball bearings enable the tool maker to "feel in" the fit of mating parts. The unit features a pilot that fits the mounting hole in standard punch holders, a longer length and a reinforced outer sleeve that give greater load capacity and prevent deflection. It incorporates an integral wiper seal and is constructed to eliminate seizure on guide pins.—*Thomson Industries, Inc., Manhasset, N. Y.*

FOR MORE INFORMATION CIRCLE 140 ON READER-SERVICE CARD

Thermal switch engineering



CPI R&D OFFERS A SUPER-HIGH TEMPERATURE CONTROL SWITCH WITH A CHOICE OF SEALING

Here's real thermal switch engineering! The original super-high temperature CPI thermal switch (to the left in the illustration) was environmentally sealed and performed excellently. However, the interest that it created for additional applications led to even further development. CPI research went to work and came up with a modification of the original super-high temperature switch.

Now the switch is available with an internally hermetically sealed head construction, using a special ceramic seal.

This is another case story of how CPI research can help solve your thermal control problems. If you have such problems now, tell us about them.

These probe-type thermal switches can be calibrated up to 1750°F. Each can safely overshoot to 2200°F or undershoot to -100°F and both exceed standards of MIL-E-5272A. Applications include gas turbines and rocket engines.

CPI



CONTROL PRODUCTS, INC.

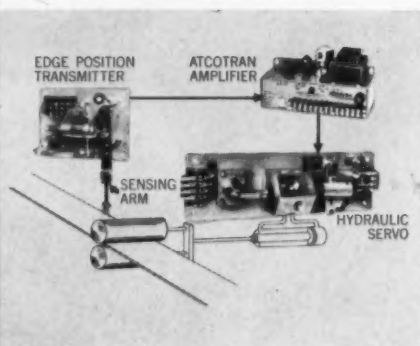
274 Ridgedale Avenue, East Hanover, N.J.

CIRCLE 45 ON READER-SERVICE CARD

DISPLACEMENT PICK-UPS FOR MACHINE AUTOMATION

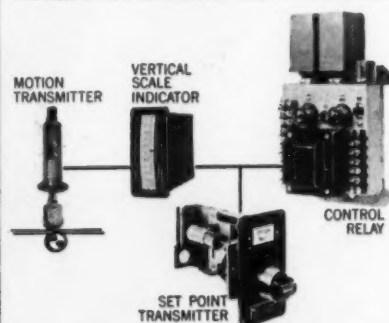
EDGE CONTROL

Atcotran Edge Guide Control maintains constant, precise edge positioning (within 0.001") for accurate register of moving web. Range is 2 1/4" with only 1/4 oz. pressure on edge. Stable null balance circuit. For paper, metals, textiles, plastics, etc.



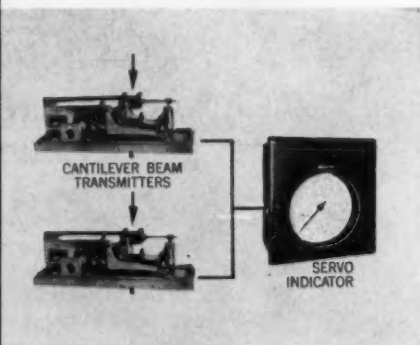
THICKNESS MEASUREMENT

ATC measuring devices for reliable automation control systems. Indicates and controls thickness to adjustable pre-set tolerance. Ideal for wallboard, sheet metal, plywood, plate glass, etc.

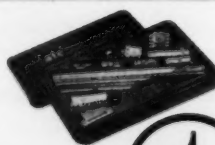


WEIGHT SUMMATION

ATC Cantilever Load Cells change force (or weight) to electrical signal, recorded as weight on servo indicator. Multiple load cells may be algebraically coupled for indication-control of force, thrust, torque, etc.



ADVANCED DIFFERENTIAL TRANSFORMER PRINCIPLE permits simple and rapid automation of machine functions using standard off-the-shelf control components, indicators, recorders, and process controllers. Discuss your applications and requirements with your ATC representative.



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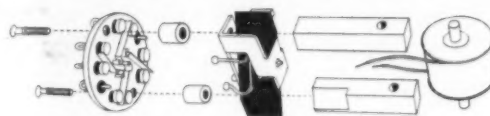
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A Subsidiary of American Manufacturing Company, Inc.

ATC, Div. of Interprovincial Safety Industries, Ltd., 5485 Notre Dame St., West, Montreal 30, Quebec

CIRCLE 46 ON READER-SERVICE CARD

Rotary Armature Relays

The ability of a relay to withstand a given level of vibration and shock depends upon several related factors. Among these are contact pressure, sensitivity, mounting method, and mechanical resonances . . . All relays are constructed with a permanent magnet or spring used to hold the armature away from the moving contacts in the unenergized position. Though a



rotary type of armature is inherently resistant to vibration and shock, minor unbalances will result in resonant conditions at certain frequencies. Without this "hold open" magnet or spring, such resonances will allow the armature to occasionally move far enough to cause slight contact opening . . .

All Hi-G relays utilize a balanced rotary armature. This type of relay construction has proved to be the best approach available for resistance to extremes of vibration and shock, exceeding all present military specifications. In addition, rugged, simple construction and a minimum number of moving parts contribute to the inherent reliability of the product . . . (From 24-page Catalog 860, Hi-G Inc., Bradley Field, Windsor Locks, Conn.)

FOR THIS LITERATURE CIRCLE 141 ON READER-SERVICE CARD

Deposited Carbon Resistors

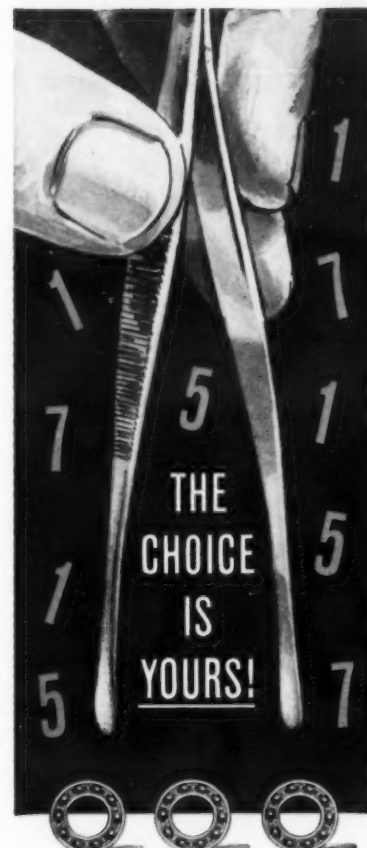
There are at present three categories into which pyrolytic resistors conveniently fall: (1) deposited carbon films, (2) boron carbon films, and (3) deposited carbon alloy films. The first group is . . . usually produced by the cracking of a hydro-carbon gas mixed with an inert gas at elevated temperatures. The resulting deposition on a ceramic substrate forms the basic resistive element. Group (2), boron carbon films, are similar to straight deposited carbon types . . . Group (3), deposited carbon alloy films, are quite new and . . . are created in a furnace consisting of a large ceramic cylinder maintained at high temperature and

6-MONTH SHELF STORAGE %ΔR

Type	Resistance	Average	Maximum	Minimum
MDA	100K	-.34	-.25	-.47
MDA	100K	+.14	+.17	+.12
MDA	499K	-.09	-.06	-.13
MDA	1 Meg	-.33	+.07	-.63

in high vacuum. The film is actually the product of the co-deposition of carbon and other elements in the furnace resulting in an extremely hard film nearly impervious to moisture and temperature . . . (From 28-page catalog, "Performance and Reliability of Deposited Carbon Resistors," which includes graphs and tables of data derived from tests involving over 37,000 IRC units, International Resistance Co., Box 502, Burlington, Iowa.)

FOR THIS LITERATURE CIRCLE 142 ON READER-SERVICE CARD



RMB

RMB miniature and instrument ball bearings are available in ABEC-1, ABEC-5 and ABEC-7 tolerances.

ONLY ONE OF THESE IS BEST FOR YOUR APPLICATION

For highly sensitive and high speed applications you'll choose the RMB ABEC-5 or -7 bearing.

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CIRCLE 47 ON READER-SERVICE CARD
MILITARY SYSTEMS DESIGN



NEW Miniature MICROWAVE OSCILLATOR CAVITIES now available

TRAK Electronics Company, Wilton, Connecticut, announces the formation of TRAK MICROWAVE CORPORATION to increase its developmental facilities for triode cavities in r-f signal generation from 500 Mc upwards. Present low, medium and high power cavities are available for application in grid pulse, plate pulse, and CW service.

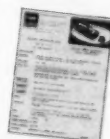
TRAK expanded its Microwave Cavity line, which started in 1949, by adding the following 7 NEW miniature Cavities in 1960:

TRAK Type 9127-L	At 1090 Mc, tuneable ± 25 Mc, available from 900—1200 Mc.
TRAK Type 2958	At 925 Mc, tuneable ± 50 Mc, available from 500—2200 Mc.
TRAK Type 2959	At 1.5 KMc, tuneable ± 50 Mc, available from 500—2200 Mc.
TRAK Type 9127-SL	At 2 KMc, tuneable ± 100 Mc, available from 800—7000 Mc.
TRAK Type 9127-S	Available in 3 segments of S-Band: 2700—3000 Mc, 3000—3300 Mc, 3300—3600 Mc.
TRAK Type C-3136	Tuneable 2700—3400 Mc.
TRAK Type 9127-C	Tuneable 5400—5900 Mc.

ALSO, OSCILLATORS ENGINEERED to your specifications!

We invite you to write for new TRAK MICROWAVE CAVITY BULLETIN.

Cavity oscillator ENGINEERS WANTED. Resumes invited.



TRAK MICROWAVE CORPORATION

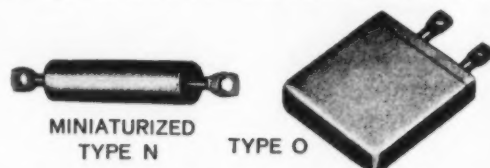
Subsidiary of
TRAK Electronics Company
5006 N. Coolidge Avenue
Tampa 3, Florida
REdwood 6-4422

CIRCLE 48 ON READER-SERVICE CARD

January-February, 1961

Cylindrical and Flat Bimetal Thermal Switches

Metal Switches . . . use a bi-metallic strip consisting of bonded layers of material of differing coefficients of thermal expansion. These bonded layers of material warp or bend with temperature changes . . . and open or close contacts at a pre-set temperature . . .

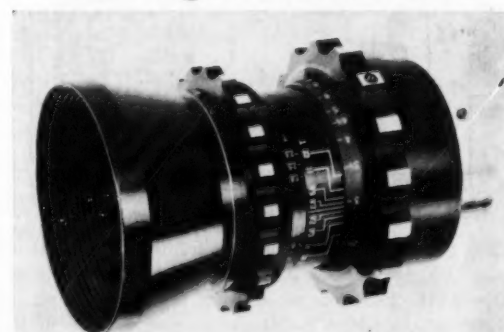


The cylindrical Type N thermal switches were originally designed to be used in conjunction with cartridge heaters . . . as a temperature control on food warmers in commercial and military aircraft. This application uncovered other uses which required a miniaturized version with lower ratings . . .

The Type O small, hermetically sealed, highly sensitive, extremely accurate flat thermostatic switch, originally designed to control skin temperatures on aircraft, is also adaptable to many other applications. It may be used to signal an unsafe surface or internal temperature of transformers, relays, etc., thus preventing overheating. It is used to control air conditioners in aircraft, and on motors and heaters. It can be immersed in non-conductive liquids to control temperatures of baths . . . (From 8-page Bulletin P-114, Control Products Inc., 280 Ridgedale Ave., East Hanover, N. J.)

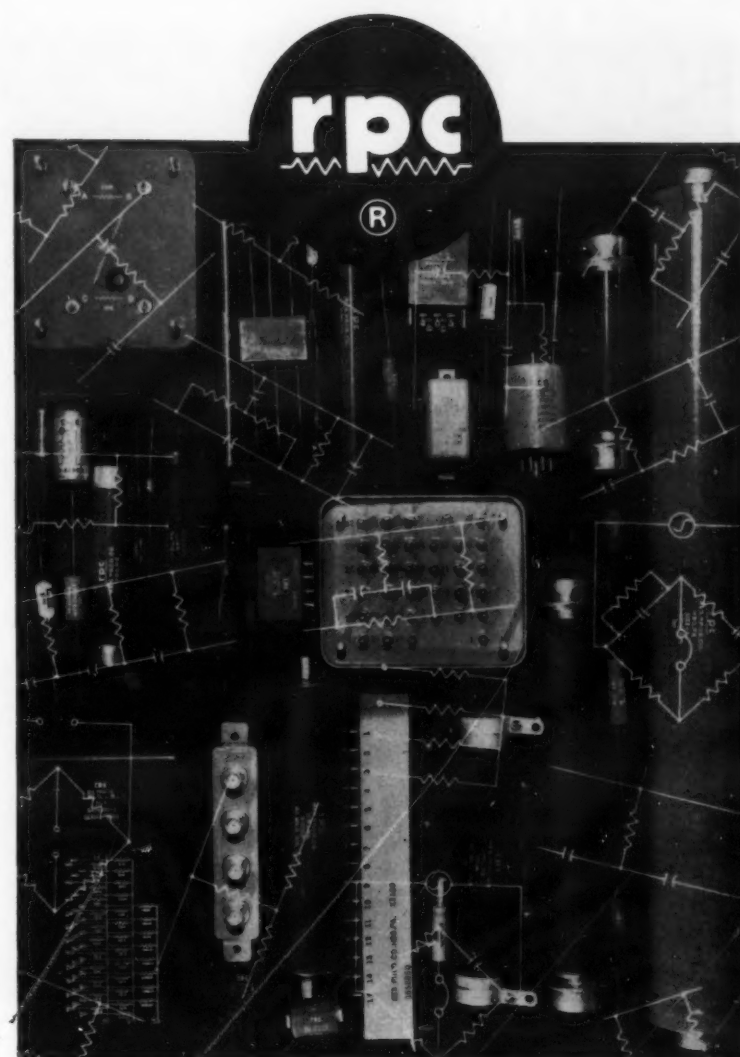
FOR THIS LITERATURE CIRCLE 143 ON READER-SERVICE CARD

New Lenses Combine Long Back Focus, Excellent Resolution and Light Distribution



New Super Baltar Lenses for motion picture, TV and special purpose applications have "excellent resolution and the most even distribution of light ever offered in a motion picture camera lens." The new series will include a choice of eight lenses, with focal lengths ranging from 20mm to 9". All focal lengths cover 35mm motion picture frame, and lengths from 3" to 9" cover 70mm frames. Back focal lengths range from 33 to 133mm. Bulletin F-162.—Photographic Sales Dept., Bausch & Lomb Inc., Rochester 2, N. Y.

FOR THIS LITERATURE CIRCLE 144 ON READER-SERVICE CARD



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CIRCLE 49 ON READER-SERVICE CARD



SURPRISING!

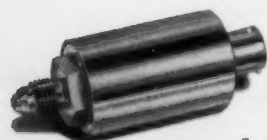
Exceptional performance characteristics of Servonic's new H-160 high pressure transducer are particularly surprising considering the small size of this potentiometer type instrument. Its 1 by 1½ inch dimensions combine with rugged design and high resolution to make it ideal for military requirements where severe environments are a problem.

Utilizing Servonic's helical bourdon assembly, the H-160 is oil damped to furnish high accuracy and long life, even under vibrations exceeding 35 g. Superior linearity over the temperature range -65° to 275° F is provided in standard construction. Individual performance characteristics have been

controlled to provide accuracies of ±1.0% error band in most ranges. The unit can be readily adapted to accommodate a wide range of exotic fluids.

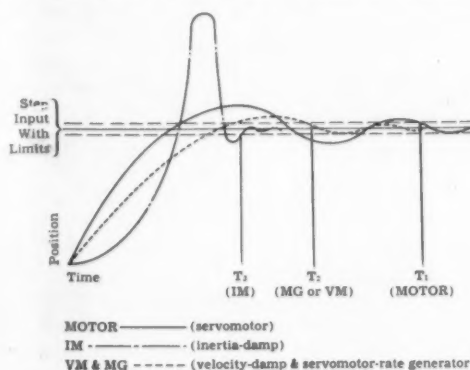
For complete specs on the H-160 and its companion, low cost industrial unit, write for Bulletin S-605.

SERVONIC INSTRUMENTS, INC.
1644 WHITTIER AVENUE, COSTA MESA, CALIFORNIA
CIRCLE 50 ON READER-SERVICE CARD



Electromagnetic Damping

Stability is one of the major problems faced by the servo-systems designer. Frequently, damping techniques are required in order for a motor to faithfully follow high gain input signals without oscillation.



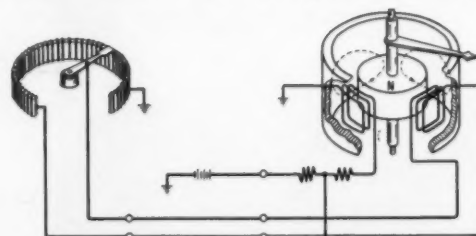
There are three common methods of obtaining this stability:

1. by decreasing speed to take advantage of the inherent damping characteristics of the motor itself,
2. by feedback of the output voltage of a damping generator,
3. by use of a notching filter to improve frequency response.

New viscous damping methods, growing in importance because of their unique advantages, are *inertial damping* and *velocity damping* . . . (From 24-page catalog, Helipot Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.)

FOR THIS LITERATURE CIRCLE 145 ON READER-SERVICE CARD

Two-Coil DC Selsyn Systems



POTENTIOMETER two-coil system.

The two-coil system is used where a scale length of up to 110° is desired . . . D-c currents from the transmitter to the two coils mounted in the indicator set up a flux pattern which holds the magnetic rotor of the indicator in a particular position. The indicator pointer is attached to the rotor and indicates the position of the flux pattern, which in turn corresponds to the transmitter position . . . When a potentiometer is used as a transmitter, the current in only one of the indicator coils is varied by the transmitter and the current in the other indicator coil always remains constant. The resultant flux pattern within the indicator will rotate and indicate the position of the potentiometer brush . . . (From 24-page Bulletin GEA-6596, Instrument Dept., General Electric, West Lynn, Mass.)

FOR THIS LITERATURE CIRCLE 146 ON READER-SERVICE CARD

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Timing Range 20 msec.-180 sec.
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Supply Voltage 18 to 30VDC
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Size 1 x 1 x 2
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D6006-3AB-3 AMPLIFIER DEMODULATOR

Input Impedance 500K (floating)
Input Signal 0-100mVRMS
Output Impedance 5.0K (floating)
Output Signal 0-5VDC
Linearity ±1%
Supply Voltage 28 ±3VDC
Reference Voltage 5VRMS min.
Size 1 x 1 x 2.5 inches
Price \$125-\$195



D6004 DEMODULATOR

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Input Signal 5.0VRMS
Output Impedance 10K (floating)
Output Signal 0 to ±5.0VDC
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Reference and Carrier Frequency 200CPS 50KC
Linearity ±1%
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9018 D.C. AMPLIFIER

Input Impedance 100K (floating)
Input Signal 0 to ±10mVDC
Output Impedance 5K (floating)
Output Signal 0 to ±5VDC
Linearity ±1%
Reference Signal 5VRMS
Supply Voltage 28 ±3VDC
Size 1 x 1 x 3
Price \$300-\$625



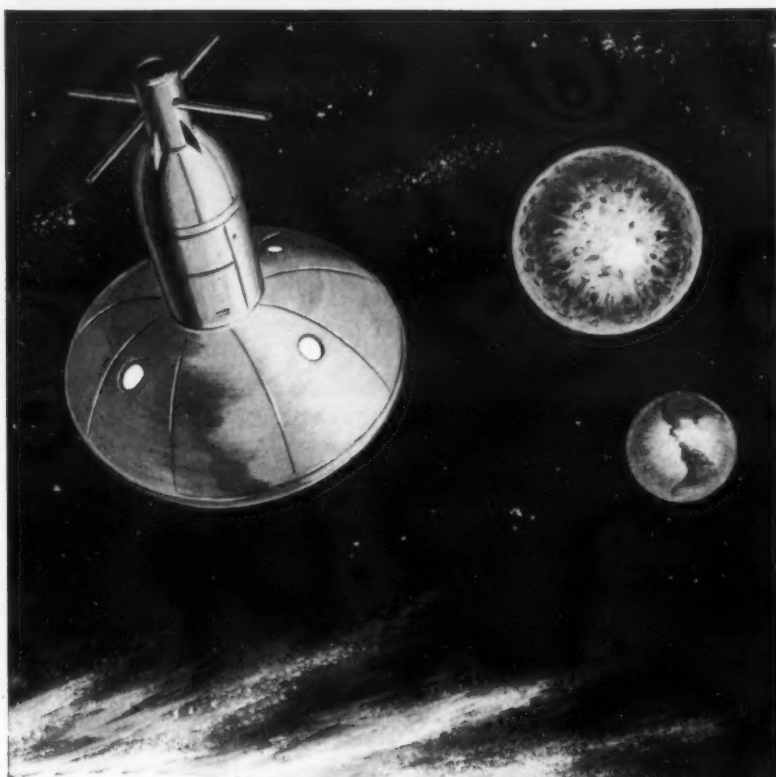
D8011 F.M. DISCRIMINATOR

Input Frequency IRIG Channels 1-18
Input Impedance 100K
Input Signal 1-3VRMS
Output Impedance 1.0K
Output Voltage ±2.5VDC
Linearity ±1.0%
Supply Voltage 28 ±3VDC
Size 2.06 x 2.31 x 3.125
Price \$190-\$350
Units include input BP and output LP filters



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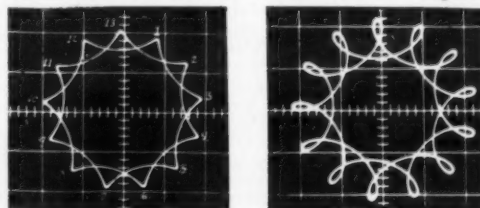


CIRCLE 53 ON READER-SERVICE CARD

January-February, 1961

Frequency Comparisons Using Roulette Patterns

High-ratio frequency comparisons by use of Lissajous figures are often difficult to observe . . . Roulettes are much easier to interpret than are Lissajous figures because slight oscillator frequency drifts cause a pattern rotation in the plane of the crt screen without a change in pattern shape. Roulettes are readily displayed with oscilloscopes having differential inputs on both the horizontal and vertical amplifiers.

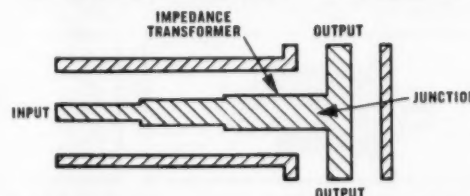


Typical patterns for an 11:2 frequency ratio are shown. The patterns differ only in that the output amplitude of the higher-frequency generator is greater in Fig. B. To determine the frequency ratio, count the total number of points on the circumference of the pattern (13 points in Fig. A). Call this number N1. Next, determine the number of points passed over in tracing from one point to another along the figure. For instance, in tracing from point 1 to point 3 in Fig. A, only one point (point 2) is crossed. Add one to this number and call it N2. The ratio of the two frequencies is given by:

$f_2/f_1 = (N_1 - N_2) / N_2 = (13 - 2) / 2 = 11:2$ for Fig. A. When no points are crossed in moving from one point to another along the trace, the ratio of frequencies is a whole number (an integer), and the ratio is simply one less than the total number of points on the pattern circumference . . . (From 4-page pamphlet, Tektronix, Box 500, Beaverton, Oregon.)

FOR THIS LITERATURE CIRCLE 147 ON READER-SERVICE CARD

Reactive Power Dividers



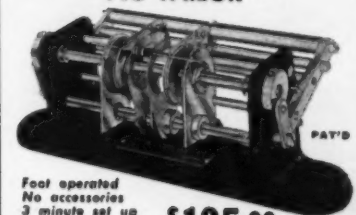
A typical reactive power divider is illustrated. The load impedances are added in parallel at the junction so that the impedance at the junction is equal to the individual impedances divided by the number of outputs. The transformer is employed to transform the impedance at the junction to 50 ohms at the input. The Impedance Transformer consists of a number of cascaded lines or sections, and is mounted in the center or input arm of the divider. Four factors must be considered in designing the transformer: the impedance ratio, the bandwidth, the transformer length, and the maximum allowable VSWR . . . (From 72-page Catalog 10, "Coaxial Components," Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J.)

FOR THIS LITERATURE CIRCLE 148 ON READER-SERVICE CARD

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PIG-TAILORING eliminates: • Diagonal cutters • Long nose pliers • Operator judgment • 90% operator training time • Broken components • Broken leads • Short circuits from clippings • 65% chassis handling • Excessive lead tautness • Haphazard assembly methods.

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Pays for itself in 2 weeks

"SPIN-PIN"®

Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

- No Training
- No Pliers
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The Tiny New PRESSURE TRANSDUCER that goes along with the BIRD!

Space is at a premium . . . accurate pressure measurements of 0.25% are required over a wide temperature range. The answer is Taber's tiny reliable TELEFLIGHT, the miniature transducer with Bonded Strain Gage construction that has extremely low sensitivity to vibration and shock. When the Teleflight is subjected to zero gravity conditions (as in space flight where convection cooling is non-existent) the Ni-Span proving ring acts as a heat sink and conducts heat AWAY from the resistance gages to the instrument case. Measures corrosive gas and liquid pressures including fuming NITRIC ACID. With factory modifications will handle Fluorine. 200% overload protection built in at no extra cost. Taber Indicators or standard make recorders can be used as read out instruments. Infinite resolution, Linearity 0.25%, Hysteresis 0.25%, Temperature - 150° to 275° F., Repeatability within 0.1%, Pressure Ranges 0-1,000 PSIA or PSIG. Taber also produces a complete line of miniature transistor amplifiers.

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North Tonawanda, N. Y.

TWX-TON 277

Exclusive feature is pressure cavity that is easy to clean out during ground testing by simply removing 8 screws.

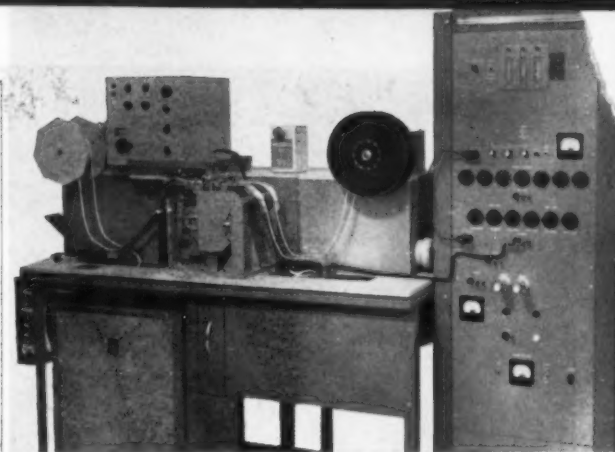


FIG. 1. AUTOMATIC Component Tester Model TCS-1. Taped components travel from supply reel on left through test assembly to takeup reel.

Hi-Speed Reliability

GREGORY DZULA

Manufacturers and large volume users of electrical and electronic parts have long felt the need for a high speed continuous method for testing resistors, capacitors and other basic components. Spot checks on production lots are, of course, unsatisfactory since 100% reliability is essential. Former manual methods requiring an operator to place an individual component in a test rig and check a meter reading were tedious, expensive and not even 100% reliable, due to operator lapses.

A new series of automatic testing machines, similar in basic operating principles and yet as specific as the job requires, is now capable of testing these components at speeds up to 5000 pieces per hour. A typical resistor testing machine, as shown in Fig. 1, is capable of testing at frequencies from dc up to one megacycle and at potentials of from 0 to 300 volts.

In the case illustrated, the resistors being tested are held between two strips of pressure-sensitive tape wound on a large reel. This is a common input setup, especially if the components are to be put into an automatic inserting—dip soldering device after testing. Other input methods are possible, however, including hopper feed, tray feed, conveyor belt, etc.

Fig. 2 shows the tape as it moves from left to right through the test head. At a particular location in its travel, test probes make contact with the component. Through suitable bridge circuitry, the component's value is checked against upper and lower tolerances which have been pre-set at the panel.

If the component tests within tolerance, it travels unmolested to the wind-up reel. If, however, it falls outside tolerance it is cut from the tape as it

CIRCLE SEAL CHECK VALVES

...no leakage, even with Helium

Proven reliability of the basic Circle Seal design, supplemented by precision production techniques, have made Circle Seal valves renowned for operational dependability in the most critical aircraft, missile and ground support applications.



200 SERIES CHECK VALVE

- Absolute zero leakage
- 0-3000 psi.
- Low cracking pressure
- Mounting versatility for any application
- Ideal in applications from vacuum to low or high pressure pneumatic or hydraulic systems encompassing the entire range of exotic fuels and oxidizers



800 SERIES CHECK VALVE LOW PRESSURE

- Perfect sealing from 0-600 psi.
- Low cracking pressure
- Minimum pressure drop
- Unaffected by O-ring swell
- Perfect for applications requiring a combination of low pressure drop and zero leakage



2600 SERIES MINIATURE CHECK VALVE

- Superior performance from 0-3000 psi.
- Leakproof sealing assured by resilient seals
- Minimum size and weight
- Suitable for mounting in any position
- Maintenance-free reliability



JAMES, POND & CLARK, INC.

2181 East Foothill Boulevard • Pasadena, California

CIRCLE 55 ON READER-SERVICE CARD

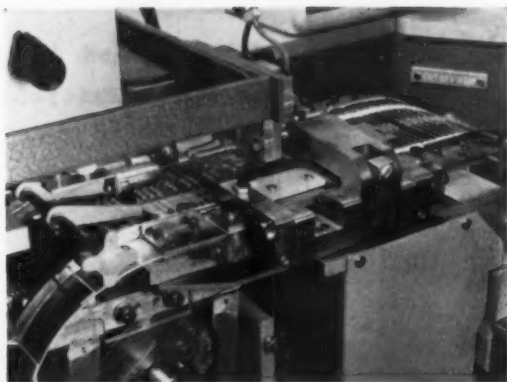


FIG. 2. TEST PROBES in the form of contact springs make contact with each component as it passes the test assembly. Cutoff knife on heavy hinged cross-bar severs leads on any component found "out of tolerance" when it arrives in cutoff position.

Automatic Tester

Chief Engineer
Industrial Instruments Automation Corp.

passes under a knife mechanism further down the line. Suitable memory circuitry actuates the cutter when the faulty piece arrives in "cut off" position.

The cut off piece is dropped into a reject bin.

Essentially this is a "Go/No Go" operation, but many refinements are possible. For example, the rejects could be sorted according to "over tolerance" and "under tolerance". It is easy to conceive of sorting within various limits merely by performing a series of tests. This could be built into a single machine, or multiple passes with different tolerance settings could be made.

Auxiliary equipment such as alarms for off-spec pieces, automatic shutdown after a pre-set number of consecutive rejects or other special operations can be added to the basic machine. Multiple tests on a single component—capacitance and leakage current on a condenser, for example—can also be done by combining the primary operations in a single tester.

While most automatic testers installed to date are being used as separate quality control devices, many have been integrated into semi-automatic production lines. By its very nature, this type of equipment lends itself to the completely automatic plant—where raw materials enter through one door and finished products exit through another. It is in this latter application, where 100% component reliability is required, that automatic testing machines can achieve their greatest design sophistication and ultimate usefulness. Engineers of the Instruments Automation Corporation, Cedar Grove, N. J. are interested in demonstrating the feasibility of this premise in specific production applications.

FOR MORE INFORMATION CIRCLE 149 ON READER-SERVICE CARD

NEW TANSITOR 125C TANTALUM CAPACITORS CUT CASE SIZE

15%



High reliability at 125C is a key feature of TANSITOR'S new TH-type foil capacitors. But they also provide average savings of 15% in case size over similar high temperature tantalum capacitors.

In short, they give you the most capacitance in the least space of any 125C tantalum foil capacitors. Their specifications also coincide with the new military specification MIL-C-3965-15 through 18.

	Plain Uninsulated	Plain Insulated	Etched Uninsulated	Etched Insulated
Polar	CL 30	CL 31	CL 20	CL 21
Non-Polar	CL 32	CL 33	CL 22	CL 23

COMPLETE LINE AVAILABLE

TANSITOR ELECTRONICS specializes in tantalum capacitors. Wire, foil, or solid types with operating ranges from - 80 to +125C, voltages from 1 to 300 and capacitances from 0.0047 to 600 microfarads are available. For full details on the new TH or other TANSITOR tantalums, write TANSITOR ELECTRONICS, INC., Dept. 40, West Road, Bennington, Vermont.

TANSITOR

ELECTRONICS

INCORPORATED

Where Reliability Comes First

Tantalum Capacitors

TH CAPACITOR CHARACTERISTICS

- Non-acid electrolyte • Single case, double sealed
- Low leakage current • Long shelf life
- Long life at 125C

CIRCLE 57 ON READER-SERVICE CARD

FACTS ABOUT COAX

CHOOSING THE PROPER COAXIAL CABLE

With coaxial cable playing an ever-increasing role in military systems, the choice of cable that will provide maximum efficiency and service must be carefully made. The criteria to consider are:

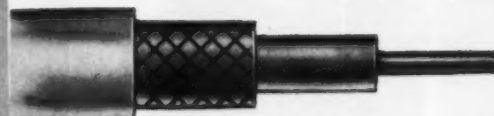
TEMPERATURE RATING. Check properties of various insulating materials for high and low temperature limits, and for power handling capacities. If the ambient temperatures of your installation are known, you can choose the proper material for both core and jacket.

ATTENUATION determines the physical size of cable. Assuming equal impedance and dielectric materials, the larger the center conductor, the lower the attenuation in cables of similar construction.

IMPEDANCE AND CAPACITANCE. Determine which of the 2 is of greater importance. If capacitance not critical, cable should be chosen on the basis of impedance desired.

OUTER JACKET. When long life and stability are vital and high temperatures are to be encountered, choose Teflon or impregnated fiberglass. For general applications, Polyvinylchloride jacketing material may be used. For critical applications under normal temperature conditions, high molecular weight polyethylene provides high solvent and abrasion resistance, long life.

Among the most popular types in use...
CABLE, RADIO FREQUENCY, COAXIAL, RG-11A/U



With solid polyethylene dielectric; single braid copper shield. Non-contaminating synthetic resin covering. Impedance 75 ohms. Max. voltage 20.5 rms. 5000 nominal capacitance (uuf/ft)

CHOOSING THE PROPER COAXIAL CABLE SOURCE

Normandy is widely recognized as the "sure source" for coaxial cable. Its Research Division has precision tested every type of every manufacturer and has selected for its stocks only the top performer in each classification. All are consistently available for immediate delivery...including hard-to-get basket-weave armored...and are priced right. CONTACT NORMANDY FOR THEIR TALKED-ABOUT NEW CATALOG—IT'S FREE!

NORMANDY

ELECTRIC WIRE CORP.

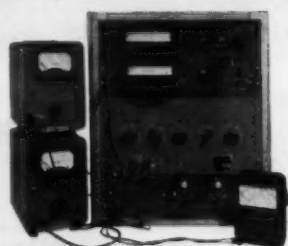
125 Second Street, Brooklyn 31, N. Y. TRiangle 5-9863
CABLE ADDRESS NORMWIRE, NEW YORK

CIRCLE 56 ON READER-SERVICE CARD

7 benefits for you with trio labs' BUILD-IN concept

By designing-in trio miniature panel-mounting instruments into operating and testing equipment, you . . .

- customize both your test set-up and instruments
- save space (average trio model is 4" x 4" x 4")
- save time: at-a-glance sequential or continuous monitoring
- save money: exclude unnecessary instrument functions, ranges
- make monitoring foolproof: read "go no-go" by switching
- improve testing efficiency and system reliability
- increase overall design freedom



BEFORE . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.



AFTER . . . 3 trio VTVMs integrally built-in now are always on hand to measure just the parameters you designate.

3 ways you can use Trio Labs' pioneer know-how . . .

1. choose from trio's complete line of "standard" models.
2. select a "special" already produced—and you save the engineering time and money that went into it.
3. consult us for design specific to your own needs.



Write for free "how to" Engineering Guide to Dept. MSD-2

TRIO LABORATORIES, INC., PLAINVIEW, L. I., NEW YORK
Export Dept: EMEC, 127 Grace St., Plainview, N. Y. © 1961

CIRCLE 58 ON READER-SERVICE CARD

Long-Life Battery

A rechargeable nickel-cadmium battery specifically designed for high-reliability, long-life outer space performance has three unique features which point the way to improved high-energy-density storage systems:

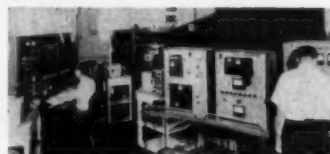


a proprietary ceramic-to-metal seal which forms a true molecular bond; a new porous synthetic sheet separator with superior stability under the severe oxidizing conditions inside the sealed cell, even at elevated temperatures; greatly improved electrical performance characteristics.

For military and space applications, the new battery has better overcharge capabilities at lower operating pressures than prior models. The 5-ampere cell is capable of absorbing a charge current of 1 ampere indefinitely. The new separator and ceramic seal enable the battery to operate for at least 20,000 duty cycles over a period of many years.—*Culton Industries, Inc., 212 Durham Ave., Metuchen, N. J.*

FOR MORE INFORMATION CIRCLE 150 ON READER-SERVICE CARD

Simultaneous Simulation of Three Dynamic Environments



A series of tests for North American Aviation's Missile Div. combined three dynamic environments at the same time. The simultaneous simulation of the severe in-flight conditions under which many components must function produced a more accurate reliability rating of the component tested than would have been achieved by applying the environments singly.

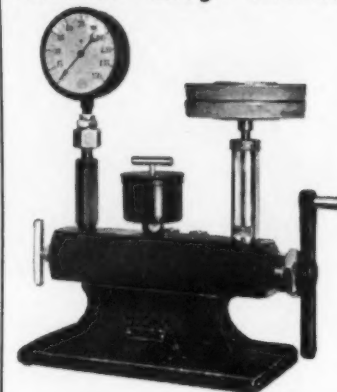
The separate parameters of the three environments were as follows:

1. Acoustic Noise: 150 db Random Noise from 37.5 to 10,000 cps.
2. Vibration: 25 G Random motion from 15 to 2,000 cps.
3. Temperature: -65° to 500°F.

Rototest Laboratories, Inc., Lynwood, Calif.

FOR MORE INFORMATION CIRCLE 151 ON READER-SERVICE CARD

AMTHOR Dead Weight Pressure Gauge TESTER



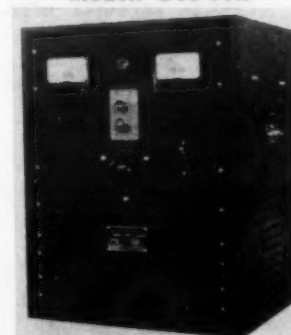
Designed for simplicity and compactness. Incorporates newest refinements and improvements in various ranges up to 10,000 P.S.I. Accuracy of 1/10 of 1%.

**ALSO BI-FLUID MODEL
USING WATER AS
PRESSURE MEDIA.
ADAPTABLE FOR GASES.**

AMTHOR
Testing Instrument Co., Inc.
45 Van Sinderen Ave., Brooklyn, N. Y.

CIRCLE 59 ON READER-SERVICE CARD

SILICON POWER RECTIFIER Model: G50-50R

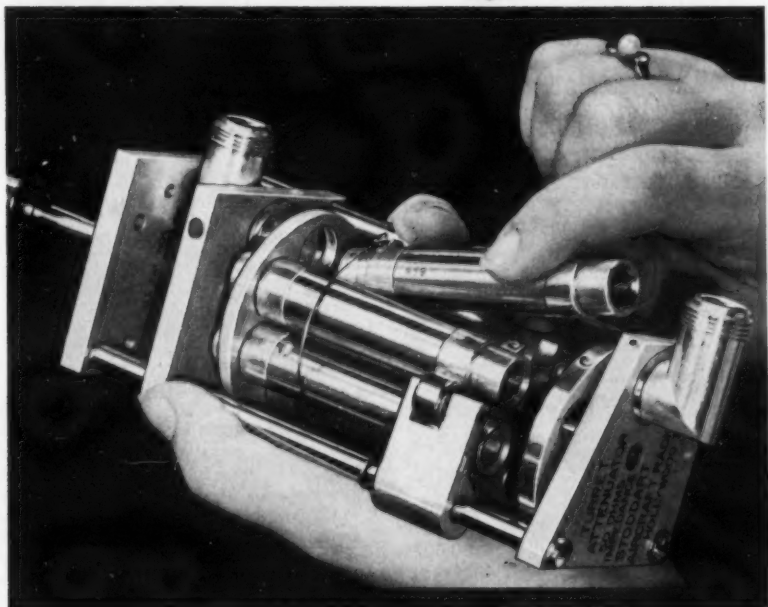
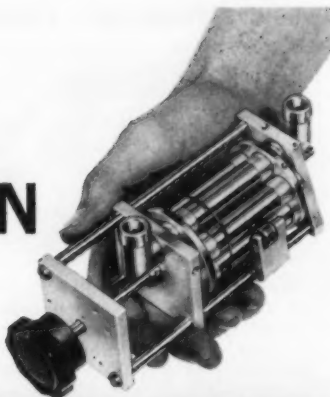


- INPUT: 220 Volts AC, 60 cycles, 3 phase
- OUTPUT: 0-50 Volts DC, 0-50 Amperes DC, Continuous duty over entire range.
- RIPPLE: 0.5% RMS
- REGULATION: no load to full load 8%
- MAGNETIC STARTER
- THERMAL overload protection
- METERS: 2% accurate
- CABINET: 28" H x 22" W x 18" D
- METERS: 2% accurate

GATES ELECTRONIC CO.
2243 White Plains Road
New York 67, N. Y.
Tulip 1-5900

CIRCLE 60 ON READER-SERVICE CARD
MILITARY SYSTEMS DESIGN

CHANGE db VALUES OF ATTENUATION IN SECONDS!



STODDART'S new turret attenuators* offer quick change of db combinations compatible to your system requirements.

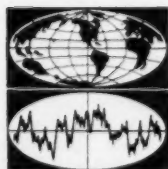
Simply remove three set screws and the pad retainer ring moves forward for easy replacement, removal or rearrangement of pads.

NET BENEFITS TO USER...

- Easy pad replacement eliminates down-time otherwise required for unit or equipment dismantling.
- No increase in price!

*Patent applied for

16-page
UHF Attenuator
Catalog No. AT-3 gives
complete details and
specifications of new
Stoddart attenuators,
terminations and
turret-type step
attenuators.



STODDART
AIRCRAFT RADIO CO., INC.

6644 Santa Monica Blvd., Hollywood 38, Calif. HO 4-9292

serving 33 countries in radio interference control

CIRCLE 61 ON READER-SERVICE CARD

January-February, 1961

Solid State Time Delay Relays

New solid state timing units for 18-32 v dc operation provide time delay either on pull-in or drop-out in a total span from 0.01 sec to 10 hr. A large selection of standard timing ranges is available, affording, in one relay, adjustment ratios of 10, 20, 40, 50, 100, 200, 1200, or 3000 to one. Fixed time models are offered in addition to internal or external adjustment types.



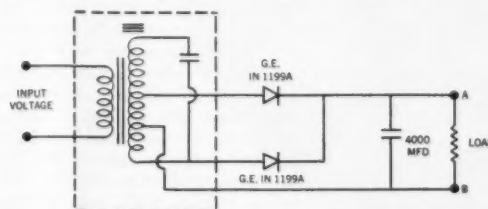
Printed-circuit panels are used throughout the new series, which are plotted and hermetically sealed for maximum environmental stability.

Two ambient range designs are available: -55° to 70°C , or -55° to 125°C with fixed-condition accuracies of $\pm 3\%$ or $\pm 5\%$. All models are protected against polarity reversals, are unaffected by continuously variable input voltage rate, and contain integral transient-suppression networks to prevent premature switching. Output may be either solid state (up to 5 amps) or relay devices (up to 10 amps). Bulletin SS-3.—Agastat Timing Instruments, Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabethtown, N. J.

FOR THIS LITERATURE CIRCLE 152 ON READER-SERVICE CARD

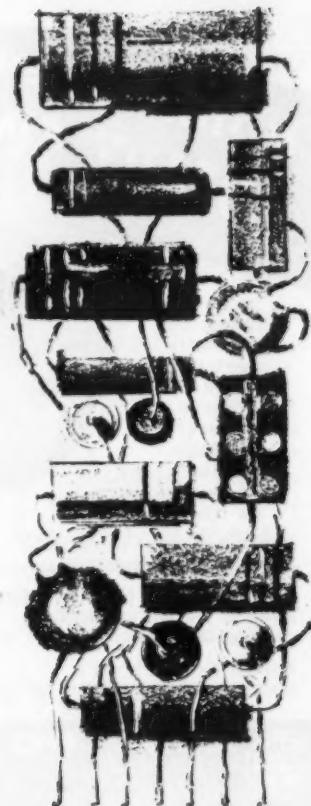
Constant-Voltage Transformer

Unique, compact CVO unit has a short-circuit overload protection and an output voltage variation with input voltage of 90-130v, which is less than $\pm 1.5\%$.

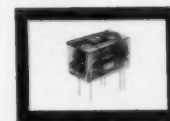


The output voltage variation, with change of load current from $\frac{1}{4}L$ to full L , is equal to $\pm 3.0\%$. . . (From 32-page catalog, Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.)

FOR THIS LITERATURE CIRCLE 153 ON READER-SERVICE CARD



WHY GO NAKED?



RELIABILITY
of Miniature Circuitry
THROUGH
ENCAPSULATION
and **QUALITY CONTROL**

Available immediately from stock... The broadest selection of encapsulated, transistorized Digital and Logic Circuit Modules... in many configurations of **PROVED RELIABILITY**... Also Custom Packaging to your specifications.

Send for data on complete line of Encapsulated, Transistorized Circuitry.

Miniature Circuitry since 1948

WALKIRT

141 W. HAZEL ST., INGLEWOOD, CALIF.
CIRCLE 62 ON READER-SERVICE CARD

MOTOR-DRIVEN ROTARY SWITCHES

Special designs to meet your performance specifications for high-speed precise multi-circuit switching in complex electric and electronic systems and instrumentation.

Built to meet severe environmental conditions and MIL specifications. Capacities and sizes from subminiature dry-circuit selectors to heavy-duty power-handling commutators.

Write for check-list to use in specifying motor-driven rotary switches.



ELECTRO SWITCH
SLIP-RING DIVISION, CORP.
OSTERVILLE, MASSACHUSETTS

CIRCLE 63 ON READER-SERVICE CARD

FOR MORE
● RELIABILITY
● RESISTANCE
● POWER

SPECIFY

CON-ELCO

FOR CIRCUIT
TRIMMING
● BALANCING
● CALIBRATION

ALL CON-ELCO TRIMMING POTENTIOMETERS AND VARIABLE RESISTORS FEATURE RELIABILITY AND ACCURACY PREVIOUSLY UNAVAILABLE TO INDUSTRY FOR CIRCUIT TRIMMING, BALANCING AND CALIBRATION.

TYPICAL SPECIFICATIONS

Power Rating: 1w, 2w and 2½ @ 50°C derate to 0 at 105°C, 150°C and 180°C
Temperature Range: -55°C to +105°C and 180°C
Resistance Range: 10 to 125,000 ohms
Humidity Seal: Mil-E-5272 Proc I and Mil-Std-202 Method 106
Terminals: Terminal configurations available include printed circuit pins, solder lugs and flexible leads.
Case: Several units are available in single or multiple unit rectangular cases.

CON-ELCO standard models are available from stock. Let CON-ELCO engineers help you with your application problems. Send for data today.




SERIES 040



SERIES 025



SERIES 037

 **CON-ELCO**
A DIVISION OF EDCLIFF INSTRUMENTS
1711 South Mountain Avenue
Monrovia, California

CON-ELCO PROVIDES
MORE RELIABILITY
IN A SMALLER
PACKAGE.

SEND
FOR
DATA

CIRCLE 64 ON READER-SERVICE CARD



DELAY LINES

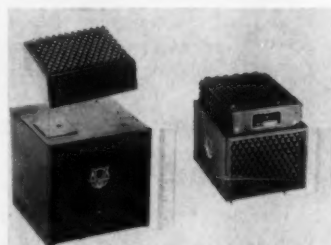
New Series DL-251 modular type electromagnetic Delay Lines (0.625" wide x 2" to 4" long) for printed circuit board applications are made of



flame-retarding-plastic. Impedances range from 300-600 ohms with delay times of 0.1-0.8 μsec. Delay time to rise time ratios of up to 10:1 available. Operating temp range -55° to +105°C.—IMC Magnetics Corp., Marketing Div., 6058 Walker Ave., Maywood, Calif.

CIRCLE 154 ON READER-SERVICE CARD

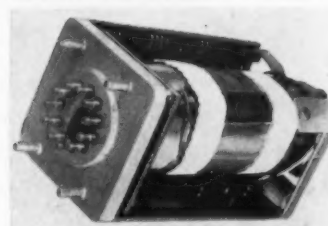
REGULATED INVERTERS



Three new 400-cycle, transistorized Victory Varia-Verter Inverters (25, 50, and 100 va) each controlled by same interchangeable regulator unit, simplify increased power output. Only power unit needs replacement; regulator plugs into it. Units feature encapsulated transformers, isolated inputs and outputs, aluminum construction, semi-conductor design, and regulation within ±1% into resistive or inductive loads. Also available, combination 100-v a inverter and 60- to 400-cycle frequency changer in modular 2-section structure. Bulletins PS-52, PS-50.—Victory Electronics, Inc., 50 Bond St., Westbury, N. Y.

CIRCLE 155 ON READER-SERVICE CARD

60-CPS FREQUENCY SOURCE

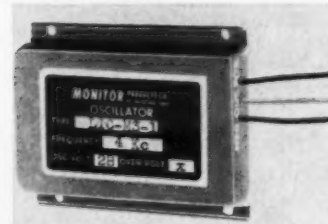


New FS17900 Frequency Source can drive (with power amplification) capstan motor of data-processing tape recorder. Heart of unit is 3.84 kc high-precision quartz crystal; 60-cps output frequency obtained by means of 6 binary frequency dividers. Meets mil spec.—Hill Electronics, Inc., Mechanicsburg, Pa.

CIRCLE 156 ON READER-SERVICE CARD

TRANSISTOR OSCILLATOR

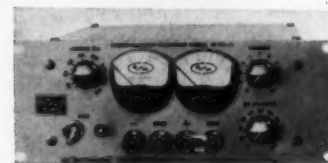
New low frequency crystal-controlled Oscillator Model LTO-M3-1 (2" x 2½" x ½") is available in either silicon or germanium. Frequency



range 3-100 kc with frequency tolerance of 3-16 kc ±0.03%; 16-100 kc ±0.02% oven controlled; ±0.001% over ambient range. Temperature range -55° to +90°C. Input voltage 20 to 28-v dc ±5%. Output voltage is 2v into 600 ohms. Total harmonic distortion less than 5%.—Monitor Products Co., 815 Fremont, South Pasadena, Calif.

CIRCLE 157 ON READER-SERVICE CARD

DC SUPPLIES



New Series TR Regatran Semiconductor DC Power Supplies (3½" x 9½") offer regulation of 0.1% or 10 mv with virtually negligible ripple; are remotely programmable, feature continuously variable current limiting, and calibrated main and vernier dc output controls. Three models: 0-100 v at 100 ma, 0-36 v at 200 ma, and 0-18 v at 1 amp. Spec Sheet 5000.—Electronic Measurements Co., Inc., Eatontown, N. J.

CIRCLE 158 ON READER-SERVICE CARD

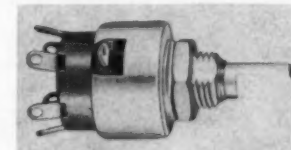
DC-AC STATIC INVERTER



New Airborne PI Series dc-ac Static Inverter supplies 28-v, single-phase, 400-cycle square-wave output from 28-v dc source. Regulation better than 8% from full load to no-load; frequency stability ±5%. Weighs 1¼ lb, measures 2" x 2½" x 2½".—Electrodynamic Instrument Corp., 1841 Old Spanish Trail, Houston 25, Texas.

CIRCLE 159 ON READER-SERVICE CARD

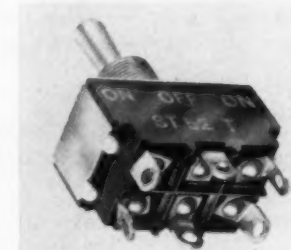
ROTARY TAP SWITCH



New Series 45 Midget Rotary Switch is rated to break 1 amp at 115-v, ac, resistive circuit and to carry 5 amp; has 100,000-cycle life expectancy. Single deck, single pole unit can be provided with 2-6 positions, with stops standard on 2-5 positions, and 6 positions normally supplied as continuous rotation.—Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill.

CIRCLE 160 ON READER-SERVICE CARD

TOGGLE SWITCH

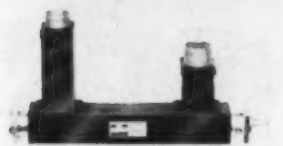


New Toggle Switches incorporate barrier design between terminals that increases leakage paths and insures safety in event of loose connection. Models for common circuits based on double-pole, double-throw or single-throw configurations, including momentary close or open functions.—Kulka Electric Corp., 633-643 S. Fulton Ave., Mt. Vernon, N. Y.

CIRCLE 161 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

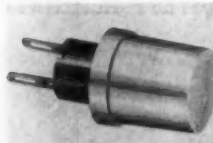
COAXIAL NOISE SOURCE



New T44L1D coaxial noise source is double-ended, covers 1-2 kmc frequency range with 18.5-db noise output, has 180-v nominal operating voltage, 50-ma operating current, 1200-v striking voltage. Used for noise measurement and testing microwave components.—Tucor, Inc., 18 Marshall St., South Norwalk, Conn.

CIRCLE 162 ON READER-SERVICE CARD

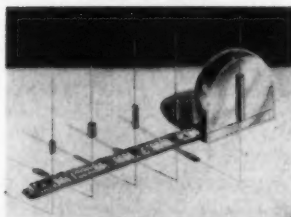
PANEL LIGHTS



New panel lights feature snap-on lenses which rotate to align markings and permit rebulbing from panel front. Lights install with clips in or behind panel, without lenses if desired. Bulletin 101.—Elotec Corp., 1425 N. Lidcombe, El Monte, Calif.

CIRCLE 163 ON READER-SERVICE CARD

RESISTORS



New miniature ($\frac{1}{8}$ " to $\frac{1}{4}$ " dia, $\frac{1}{4}$ " to 1" long) precision wirewound Resistors for computer and high reliability applications have special internal flanges to secure axial wire leads to body, preventing structural failure during assembly or use. Encapsulated in epoxy, meet mil specs. Bulletin 70.—Shallcross Mfg. Co., Selma, N. C.

CIRCLE 164 ON READER-SERVICE CARD

MICROFILM ATTENUATORS



New microfilm attenuator materials can be applied in films as thin as 0.004" on microwave pistons and plungers and on inner walls of cavities to prevent leakage of energy, thus providing for greater gain ratio in microwave equipment. Can be used from -60° to $+300^{\circ}\text{F}$; special formulations to 500°C .—United Products, 165 Franklin Ave., Nutley, N. J.

CIRCLE 165 ON READER-SERVICE CARD

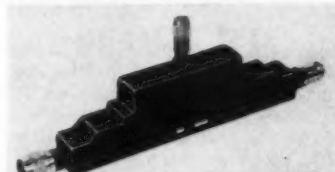
COAXIAL RELAYS



New SPDT coaxial relays with low crosstalk and VSWR are for receiver-to-transmitter antenna switching in mobile and stationary radio, VHF, UHF and TV. Antenna transfer rating is 150w max to 470 mc in properly terminated 50-ohm line. Crosstalk, 40 db min. 0-470 Mc; VSWR, less than 1.2, 0-1000 Mc. Series includes Type RB, 1w (25°C); RBA, 2w (80°C) and RBB, 2w (125°) nominal coil power ratings at ambient temps. Coil voltages 6 to 115 v.—Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.

CIRCLE 166 ON READER-SERVICE CARD

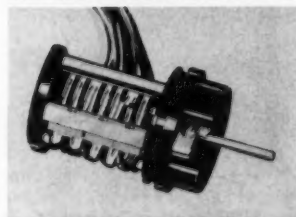
COAXIAL ATTENUATOR



New high power coaxial attenuator continuously withstands 100 w of CW power for 24 hr with no change in performance. Offers zero insertion loss and provides up to 60 db of attenuation in 300-5000 Mc frequency range.—Merrimac Research & Development, Inc., 517 Lyons Ave., Irvington, N. J.

CIRCLE 167 ON READER-SERVICE CARD

ROTARY COMMUTATORS



New Rotary Commutators for analog-digital conversion, telemetry, scanning, programming, etc. feature gold or rhodium-plated contacts embedded in epoxy, diamond turned to 4-6 μin stepless finish. Commutating surfaces engaged by special broom-type multiple strand brushes produce minimum noise and life expectancies exceeding 2×10^7 cycles to 2000 rpm.—Airflyte Electronics, 535 Avenue A, Bayonne, N. J.

CIRCLE 168 ON READER-SERVICE CARD

FREE! the Catalog that has everything in

ELECTRONICS

for
INDUSTRY, DEFENSE, BROADCAST



452
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New FM Deviation Meter has carrier frequency range 4-1024Mc; crystal controlled LO enables measurement down to 10cps deviation. Used with a 'scope, it measures peak deviation of complex wave-forms. Very easy to operate, Model 791D speeds deviation measurements.

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21 tubes: 6AK5, 6C4, 6B2, 5651,
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INSTRUMENTS

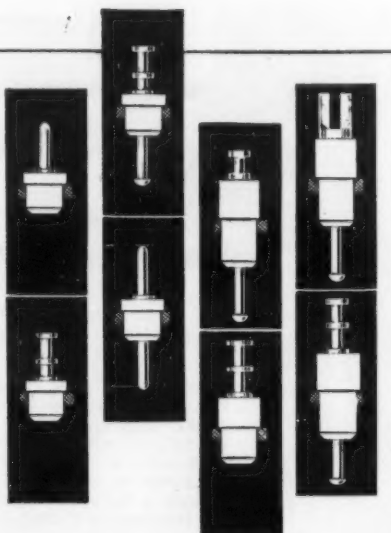
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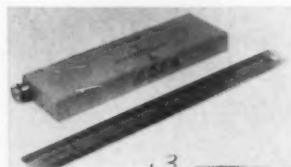
CIRCLE 68 ON READER-SERVICE CARD

ADVERTISERS . . .

Special emphasis for March-April MSD is *Logic Elements and Micro Relays*. Also, this is a Fosdick "Ad Readership Study" issue.

Contact any MSD rep—see inside front cover for addresses. Ads accepted to April 1, 1961.

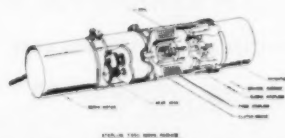
DELAY LINE



New miniaturized compact Delay Line Type V887 for printed circuit applications is continuously variable from 0 to 0.5 μ sec. Hermetically sealed unit's locking device prevents delay changes under vibration without affecting set delay. Impedance, 1000 ohms; rise time, 0.08 μ sec; attenuation, 0.3 db; resolution, 0.001; temp coefficient, better than 150 ppm. —Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway West, Woodside 77, N. Y.

CIRCLE 169 ON READER-SERVICE CARD

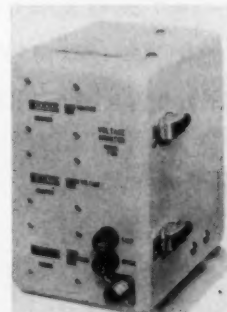
SERVO PACKAGE



New T950 Servo Package has size 11 servo motor with 400-cps frequency, 0.63 oz-in torque at stall, 0.81-w max power output; speed reducer available in ratios from 5.3-1 to 1267.7-1; 24-v dc clutch. Catalog 250. —Sterling Precision Corp., Component Div., 5 Sintsink Dr., Port Washington, L. I. N. Y.

CIRCLE 170 ON READER-SERVICE CARD

VOLTAGE MONITOR



New T166 Voltage Monitor for 115-v, 400-cps power systems records and displays total operating time (hours), total overvoltage time (minutes), and total undervoltage time (minutes). Readout capacity 9999.9 minutes for over- and undervoltage, 9999.9 hours for total operating time. Accuracy within ± 0.25 volts of initial set voltage, ambient temp range is -50° to $+130^{\circ}$ F. —Avtron Manufacturing, Inc., 10409 Meech Ave., Cleveland 5, Ohio

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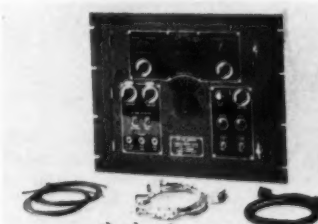
FIXED ATTENUATOR



New Model A-13 precision coaxial Attenuators operate from dc to 10 kmc, can be supplied from 0 to 60 db. Accuracy to 30 db (including absolute accuracy and variation of attenuation as function of frequency) is $\frac{1}{2}$ db; accuracy from 30 to 60 db is $\frac{3}{4}$ db. VSWR with Type N connectors is 1.3 max from dc to 10 kmc. Power rating is 1 watt. —RLC Electronics, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y.

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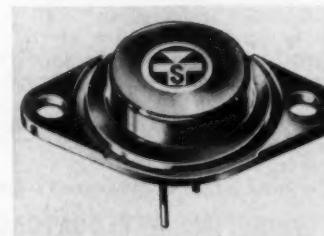
TEST GENERATOR



New VOR Test Generator, electro-mechanical audio-frequency signal generator, provides signals required to test and calibrate VOR monitors and ground check VOR stations. Unit supplies variable phase signal and two frequency modulated reference phase signals 180° out of phase. Reference-phase signals each have center frequency of 9960-cps modulated at 30 cps. —Systems Inc., Box 7726, Orlando, Fla.

CIRCLE 173 ON READER-SERVICE CARD

SILICON TRANSISTORS

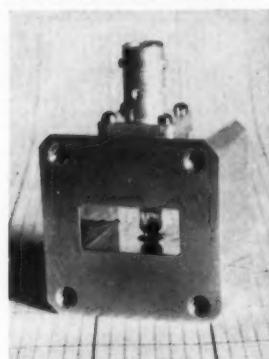


New silicon Transistors Types 2N1487, 2N1488, 2N1489 and 2N1490 are diffused junction, NPN high power units for use in power converters, power supply regulators, relay replacements and controls, as well as dc and servo amplifiers. Power dissipation at mounting flange temp of 25° C, 60 watts. Range of Beta for 2N1489 and 2N1490 is 25 to 75 with saturation resistance of max 0.67 ohms measured at 1.5 amp. —Silicon Transistor Corp., Carle Place, L. I., N. Y.

CIRCLE 174 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

WAVEGUIDE SWITCH



New WR-90 Series SMA Waveguide Switch/Modulator/Attenuators for microwave RF switching, amplitude modulation of CW carriers, square-wave chopper, etc., feature 1" insertion length, less than 10-millisecond switching time. Frequency range, 8.2—12.4 kmc; RF controlled power, 100 mw; modulation frequency, dc to over 100 mc; modulation power, 50 mw; dynamic attenuation range, 14.0 db at 10,000 mc (typical).—*Somerset Radiation Lab., Inc., 192 Central Ave., Stirling, N. J.*

CIRCLE 175 ON READER-SERVICE CARD

SILICON TRIGISTOR



New silicon Trigistor PNP device for logic circuitry in 1-8 ma range features complete on-off control at single base terminal, with ma drive requirements. Simplifies many circuits, reduces required components as much as 50%. Active elements isolated from case. Bulletins C410-01 and D410-02.—*Solid State Products, Inc., 1 Pingree St., Salem, Mass.*

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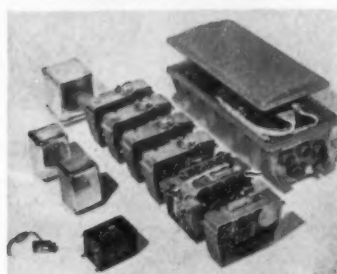
DELAY LINE



New low cost, high quality lumped-constant Delay Line features delay total of 2.4, ± 0.2 μ sec, max output noise of 0.2 equivalent to 4%. Output rise time 0.165 μ sec max, attenuation 15% maximum, impedance 300 ohms $\pm 5\%$. Developed for transistorized computer coding application.—*Essex Electronics Div., Nytronics Inc., 550 Springfield Ave., Berkeley Heights, N. J.*

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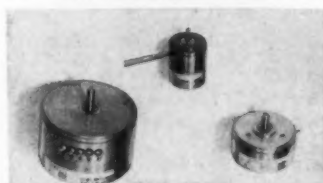
POWER SUPPLIES



New dc power supplies for aircraft and missiles can be applied to ground support equipment. All-silicon Model AU-0192 has efficiency of 80-85%, produces 550-w with 6 outputs from one 22 to 32-v input, $\frac{1}{2}\%$ regulation from -55° to 100°C . Model AU-0291 gives ac to dc isolated outputs at 60 cps. Model AU-0109 handles large amount of power for dc to dc conversion. Model AU-0241 (3-oz unit) has short circuit protection, is regulated for input variations, provides 28-v with 50-ma output current, 1.4-w power.—*Jordan Electronics, 3025 W. Mission Rd., Alhambra, Calif.*

CIRCLE 178 ON READER-SERVICE CARD

SINE-COSINE POTS



New PSC Sine-Cosine Series potentiometers (1"-6" dia) are available in any conformity from 1.0 to 0.1% peak-to-peak. Aluminum-cased units screw together, do not increase body diameters. Integrated epoxy terminals; $\frac{1}{8}$ " and $\frac{1}{4}$ " shaft diameters.—*Accuracy, Inc., 4 Gordon St., Waltham, Mass.*

CIRCLE 179 ON READER-SERVICE CARD

LINEAR MOTION POTS



New $\frac{1}{2}$ "-dia Linear Motion Potentiometers Types 3239 and 3209 for servo control systems and instrumentation transducers in aircraft and missile applications are for designs with inherent space limitations and high performance, continuous-duty requirements. Features: independent linearities of $\pm 0.5\%$ or better, element resistances ranging from 1K to 20K ohms. Type 3239 shaft stroke length, 1.587"; Type 3209 shaft stroke length, 0.600".—*Markite Corp., 155 Waverly Place, New York 14, N. Y.*

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SPECIFICATIONS

Excitation: to 24 VDC

Range: $\pm .050"$ to $\pm .50"$

Scale Factor: to 100 V/in. DC

Linearity: 0.5 %

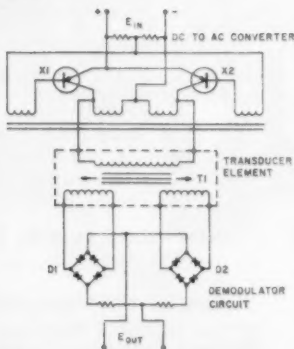
Dynamic Response: exceeds
1000 CPS

Resolution: infinite

Stability: 0.1 % F.S.

Temperature: to $+275^{\circ}\text{F}$

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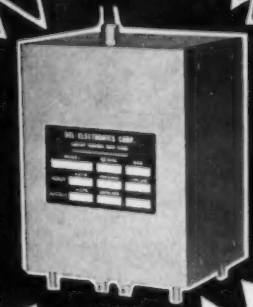


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1 KV DC-5 MA to 20 KV DC-1 MA

MODEL NO.	OUTPUT	SIZE
1RS-1	1 KV-5 MA	4 1/4" x 3 3/4" x 5 1/2"
2SR4-1	2.5 KV-4 MA	4 1/4" x 3 3/4" x 5 1/2"
5R2-1	5 KV-2 MA	4 1/4" x 3 3/4" x 5 1/2"
7SR1.5-1	7.5 KV-1.5 MA	4 1/4" x 4" x 6"
10R1-1	10 KV-1 MA	4 1/4" x 4" x 6"
10R2-1	10 KV-2 MA	6 1/4" x 4 1/4" x 7 1/2"
15R1.5-1	15 KV-1.5 MA	6 1/4" x 4 1/4" x 7 1/2"
20R1-1	20 KV-1 MA	6 1/4" x 4 1/4" x 7 1/2"

FEATURES

- All solid state
- Fast response time
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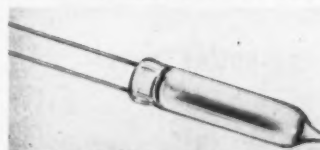
D-P TRANSDUCER



New Model CP53D dc output variable reluctance, differential-pressure Transducer has ac-dc input circuit, operates from 115-v line or 28-v dc. Accurate low differential-pressure measurement from ± 0.1 to $\pm 2,500$ psid, in presence of line pressures to 5,000 psi; 0-5 v dc output.—*Pace Engineering Co., 13035 Saticoy St., North Hollywood, Calif.*

CIRCLE 181 ON READER-SERVICE CARD

GLOW DISCHARGE VR TUBE



New Type VX62 and VX64 Voltage Regulator Tubes are of glow discharge type, regulate 95 and 150 volts, respectively.—*Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

CIRCLE 182 ON READER-SERVICE CARD

CONSTANT CURRENT SUPPLY



New transistorized Constant Current Supply, Model 151, provides constant current regardless of voltage drop across load. Output is 0.5 to 500 ma in three ranges, regulated to within 0.25% on 0-20 v load and 105-125 v a-c line. Ripple never exceeds 50 μ amp at peak output and is as low as 1.5 μ amp on lower ranges.—*Quantech Labs., 60 Parsippany Blvd., Boonton, N. J.*

CIRCLE 183 ON READER-SERVICE CARD

PORTABLE DIODE TESTER



New 12-lb, 11 1/2" x 10" x 10" Model DTM-1001 tests diode matrix boards used with 16- or 28-switch electronic timers, checks presence and correct polarity of diodes, tests diode forward current at 1v and reverse leakage current at 25v. Operates from any standard 115-v ac 60-cycle power source from 40° to 150°F.—*A. W. Haydon Co., Culver City, Calif.*

CIRCLE 184 ON READER-SERVICE CARD

PRECISION FORK OSCILLATOR



New sub-miniature Precision Fork Oscillating Unit of bimetal, hermetic-alloy sealed is 2 1/8" x 1/2" dia, weighs 2 oz. Termination is 7-prong miniature base. Stock frequencies are 400 and 500 cycles; units available from 200 to 1000 cycles. Meet mil-specs.—*American Time Products, Inc., 61-20 Woodside Ave., Woodside 77, N. Y.*

CIRCLE 186 ON READER-SERVICE CARD

TUBULAR RELAY

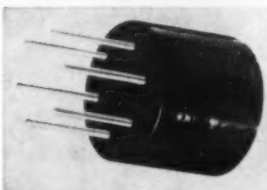


New Series 123 Tubular Relay (1 1/8" x 15/32" dia) features vibration and shock immunity, low (350 mw) coil power, and simplified mounting. Contact rating: 2 amp at 115-v ac or 24-v dc for 30,000 operations; 1 amp at 115-v ac or 24-v dc for 1,500,000 operations; 3 mls at 115-v ac or 24-v dc for 50 million operations. For use in missiles and printed circuits.—*Wheelock Signals, Inc., Long Branch, N. J.*

CIRCLE 187 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

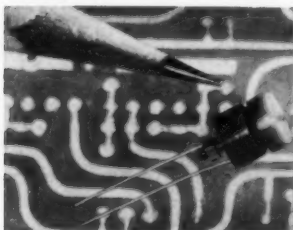
PULSE TRANSFORMER



New Pulse Transformer operates in blocking oscillator circuit and includes use of high quality ceramic ferrite cup core. Rugged encapsulated construction enables its use in salt atmosphere marine applications.—*Lockheed Electronics Co., Avionics and Industrial Products Div., 6201 E. Randolph St., Los Angeles 22, Calif.*

CIRCLE 188 ON READER-SERVICE CARD

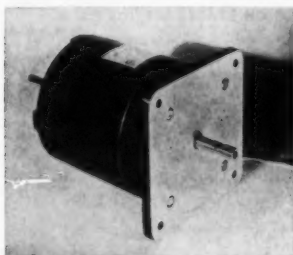
MINI TRIMMER POTS



New Trimmer Potentiometers for use in potted and hermetically sealed circuitry feature micro size ($\frac{1}{4}$ " dia x $\frac{3}{8}$ "; 0.02 oz) and extreme resistance to shock and vibration. Standard resistance values from 100 to 10,000 ohms; operating temp -55° to 150°C . Mounting: Model PC-1 has one 0.80 N.F. Stud plus lead mounted; Model PC-2 has 3 leads on 0.10" sq.—*Miniature Electronic Components Corp., Holbrook, Mass.*

CIRCLE 189 ON READER-SERVICE CARD

4500 FRAME SIZE MOTORS



New 4500 frame series of ac motors (5 $\frac{3}{4}$ " OD) are available with single-phase, two-phase or three-phase inputs, 26-230 v, and frequencies from 25-400 cps. Outputs to 1 $\frac{1}{2}$ hp as induction motors, up to 300 in-oz stall torque as torque motors, and from 1/200 to $\frac{1}{2}$ hp as hysteresis synchronous motors. Ambient temp range -55° to $+71^{\circ}\text{C}$ (std), to 150°C (special).—*IMC Magnetics Corp., Marketing Div., 6058 Walker Ave., Maywood, Calif.*

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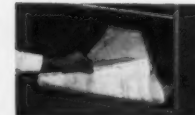


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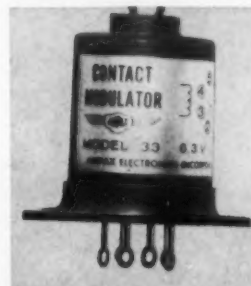
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LOW NOISE CHOPPER



New electro-mechanical Model 33 Chopper achieves noise levels of 0.6 μ v rms. Characteristics: drive, 6.3 v at 60 cps; dwell, 175° average; phase, 25° \pm 10°; balance, within 15°.—*Airpax Electronics Inc., Cambridge Div., Cambridge, Md.*

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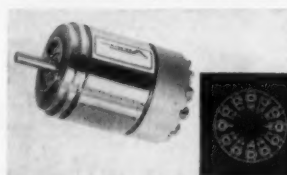
CRYSTAL OSCILLATORS



New precision Crystal Oscillators for use in communications systems, airborne electronic equipment, and guided missiles contain silicon transistor oscillator circuit, are in frequency range of 1 to 5 mc, have 24-hr frequency stability of $\pm 2 \times 10^{-7}$.—*Electronic Devices Dept., Industrial Systems Div., Hughes Aircraft Co., International Airport Sta., Los Angeles 45, Calif.*

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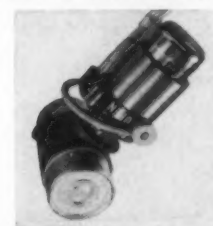
RESOLVERS/SYNCHROS



New Computing Resolvers with non-bifilar compensating winding withstand 500-v dc between stator and compensator for 1000 hr; have 0.05% accuracy. Available in 23, 15, and 11 frame sizes, also with bifilar compensating winding. New Size 8 Control Synchros feature accuracy and stability from -55° to +125°C, are available in two types of terminal blocks. Max electrical errors of ± 5 , ± 7 , and ± 10 minutes can be specified for all synchros with standard 11.8-v input and synchro transmitters with 115-v input and 11.8-v output.—*Vernitron Corp., 123 Old Country Rd., Carle Place, L. I. N. Y.*

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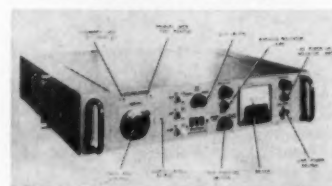
VACUUM COAXIAL RELAY



New Type RC5 Vacuum Coaxial Relay provides flexible means of remotely or manually switching 50-ohm, 1% coaxial lines for TV, communications, and radar transmitters. Frequency range of 0-100 Mc with VSWR of 1.02 max at 30 Mc, 1.05 max at 60 Mc; power rating 25 kw cw average at 30 Mc into matched load; greater than 60-db isolation at 30 Mc. Available with 24- or 115-v dc solenoids, 2 SPDT microswitches as auxiliary contacts for remote indication.—*Jennings Radio Mfg. Corp., Box 1278, San Jose 8, Calif.*

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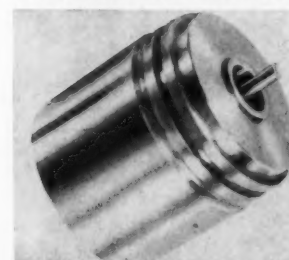
FREQUENCY STANDARD



New transistorized Frequency Standard Model RD-180 provides highly stable output frequencies of 5 Mc, 1 Mc and 100 kc for use in frequency control systems. It offers stability of ± 5 parts in 10^{10} per day. Emergency battery source provides continuous operation with automatic switchover in event of line failure.—*Manson Laboratories, Inc., 375 Fairfield Ave., Stamford, Conn.*

CIRCLE 195 ON READER-SERVICE CARD

SYNCHRONOUS MOTOR

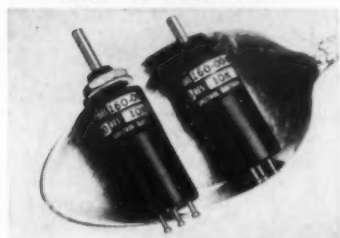


New Model A3361, 400-cycle Hysteresis Synchronous Motor is 0.960" long, provides constant speed drive for computers and navigational devices. Torque (pull-in), 0.025 oz-in; synchronous speed, 8000 rpm at 55-v; total power, 5.1 w.—*Kollsman Motor Corp., Dublin, Pa.*

CIRCLE 196 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

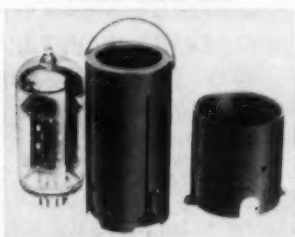
MINI 10-TURN POT



New $\frac{1}{2}$ " dia 10-turn precision potentiometer (Model 160) with resistance to 200K ohms has linearity tolerance of $\pm 0.5\%$ (standard), to $\pm 0.05\%$ (special). Terminals mounted on rear housing lid protrude from end, provide true $\frac{1}{2}$ " dia pot without projections. Pot fits inside $\frac{1}{2}$ " cylinder.—Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif.

CIRCLE 197 ON READER-SERVICE CARD

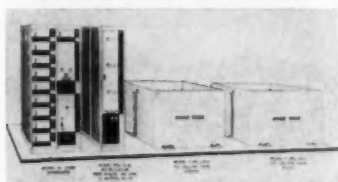
TUBE SHIELDS



Heat-dissipating tube shields for new 9T9 type tubes provide full length contact between the shields, spring finger inner liner and glass bulb surface. Heat is transferred from hot bulb to shield by liner, then dissipated. Shield locks into base mounted to chassis; assembly retains tube in shock and vibration environments.—IERC Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

CIRCLE 198 ON READER-SERVICE CARD

ULTRASONIC CLEANING



New 25,000-watt Ultrasonic System for precision cleaning parts of Atlas missile consists of two 500-gal transducerized tanks (one for cleaning, one for rinsing) alternately activated by transistorized 20-kc generator in modular form. Automatic tuning assures maximum cleaning power at constant rate. Replaceable cartridges allow for filters ranging from 1 to 50 microns.—Marketing Dept., Acoustica Associates, Inc., 10400 Aviation Blvd., Los Angeles 45, Calif.

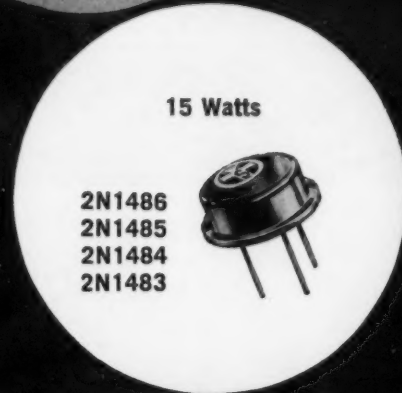
CIRCLE 199 ON READER-SERVICE CARD

CIRCLE 75 ON READER-SERVICE CARD

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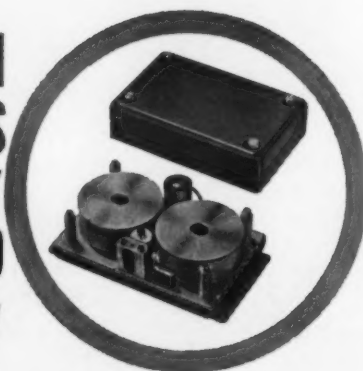


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CIRCLE 76 ON READER-SERVICE CARD

Electroplated WIRES

For the semiconductor field a wire such as Nickel may be Gold plated and subsequently electroplated with either a Group III or Group V metal, thereby providing a "doped" electroplate.

Another application is the electroplating of a high melting point wire such as Nickel with Indium as a low melting point solder. Many other combinations are achievable.

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CIRCLE 77 ON READER-SERVICE CARD

Spring-Energized Gyro for Ballistic Devices

A new low cost spring-energized gyro has been designed to provide an inertial reference for short duration missiles and other ballistic devices.

Called Model 1091, the entire self-contained package weighs about $3\frac{3}{4}$ lb and is 5" long by 4.2" diameter.



The MEMCOR gyro has segmented pickoff commutators on its outer gimbal for roll reference information.

Unlatching is via either one or two 28-v dc dimple motors, followed automatically by uncaging which takes a minimum of 100 msec.

Full speed of 3330 rpm is attained in 100 msec, and run-down time is 7 to 9 minutes. MEMCOR reports that the 1091 gyro achieves an angular momentum of $737,000 \text{ gm cm}^2/\text{sec}$ with a moment of inertia at 2116 gm cm^2 . The gyro incorporates simplified design and fewer parts than conventional mechanically operated gyros, resulting in low cost.—*Courter Products Div., Model Engineering and Manufacturing Corp. (MEMCOR), Boyne City, Mich.*

FOR MORE INFORMATION CIRCLE 200 ON READER-SERVICE CARD

Test Turntables

The Sterling T800-D Turntable is basically the 26" diameter M.I.T. "D" Table modified to incorporate the most recent advances in the design of high precision inertial test equipment. It is a single axis, tiltable servo-driven platform used for low-rate drift testing of hermetically sealed rate-integrating gyros such as the "HIG" type. Notable features include provision for ultra-precise multiple speed Earth Rate Drive and Choice of either high resolution photo-electric scale readers or electro-static pickoff system to give table position read-out every five seconds of arc with an accuracy of one second . . . (From 24-page Catalog 153 which includes descriptions of Rate Turntables, Gyro Test Sets and Consoles, and accessories.—*Inertial Products Dept., Dunn Engineering Associates, Inc., 17 Matinecock Ave., Port Washington, N. Y.*)

FOR THIS LITERATURE CIRCLE 201 ON READER-SERVICE CARD

POTENTIOMETER



New infinite resolution, multi-turn, wire wound Potentiometer has precious metal, light contact brush that slides across single wound length of resistance wire, following exact helical path of wire. No sliding or helical error occurs between contact and wire, insuring long wire life, stepless output, accuracy, low electrical noise, and independent linearity of 0.01%. Available in 1 to 10 turns with 1-3000-ohm resistance range; Model 100A for panel mounting, Model 106S for servo mounting.—*Vogue Instrument Corp., Electronics Div., 381 Empire Blvd., Brooklyn, N. Y.*

CIRCLE 202 ON READER-SERVICE CARD

SHIELDED RF INDUCTORS



New Series 900 slug-tuned, shielded RF Inductors cover range of inductance from 0.5 to 100 μH in 10 steps and are most useful over 0.5 to 60 Mc spectrum where average Q is 70. Uses: in telemetering, radar, and communications equipment.—*North Hills Electronics, Inc., Glen Cove, L. I., N. Y.*

CIRCLE 203 ON READER-SERVICE CARD

SPECTRUM ANALYZER



New high resolution Spectrum Analyzer Model MD-500 has two inputs that allow for conversion of any signal in 450 kc to 100 Mc range with use of external oscillator and automatically scanning difference frequencies. Signals separated by only 10 cycles can be resolved.—*Probescope Co., Inc., 8 Sagamore Hill Dr., Port Washington, N. Y.*

CIRCLE 204 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

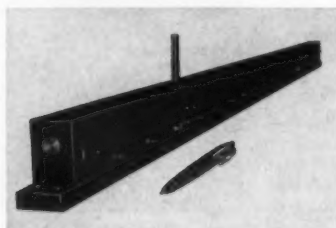
HOT AIR CHAMBER



New diffused Aer-Heet Chamber employs horizontal convection to attain exact temps to max 550°F across entire area of each shelf, features finest temperature gradients.—Dept. 1, Temperature Engineering Corp., Riverton, N. J.

CIRCLE 206 ON READER-SERVICE CARD

TRANSLATORY POTS



New Model PT37-1 with 37" stroke and non-linear output accurate to $\pm 0.05\%$ is one of largest translatable units ever fabricated. Strokes can be provided to any length. Stroke Tolerance, $\pm 1/32"$ std to $\pm 0.010"$ special; Standard resistance range, 50 ohms/in to 50k/in; Accuracy of total resistance, $\pm 5\%$ std to $\pm 1\%$ special.—Accuracy, Inc., 4 Gordon St., Waltham 54, Mass.

CIRCLE 207 ON READER-SERVICE CARD

BOOK REVIEWS

ADAPTIVE CONTROL PROCESSES, by Richard Bellman, (1961) Princeton University Press, Princeton, N. J. 256 p., 6" x 9", \$6.50. Theory of dynamic programming is developed and applied to formulate, analyze and prepare control processes using digital computer techniques. A product of Rand Corporation research.

FOR MORE INFORMATION CIRCLE 208 ON READER-SERVICE CARD

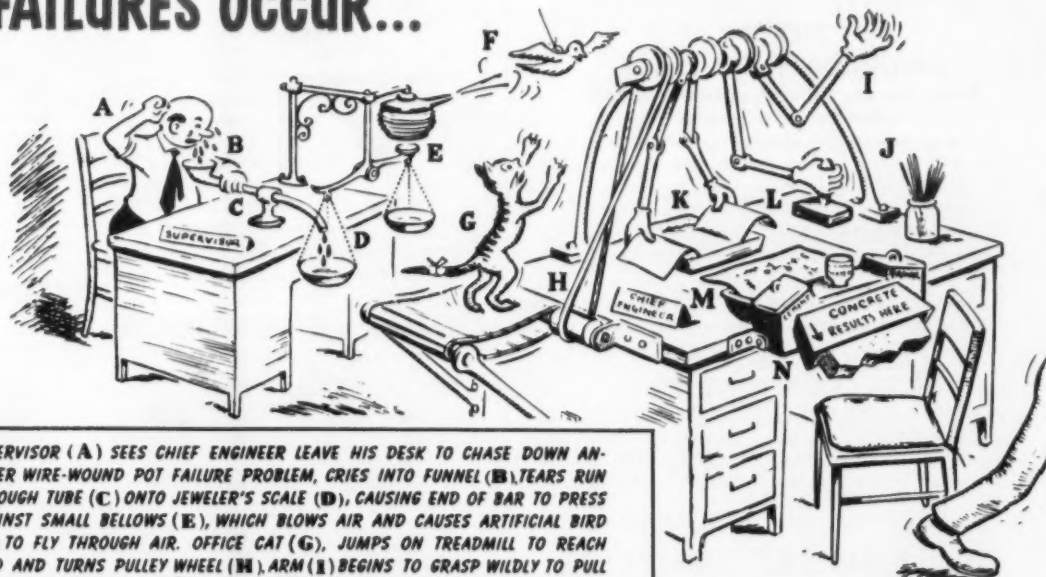
DIGEST OF MILITARY ELECTRONICS by Staff, Government Services, RCA Service Company, a Division of Radio Corporation of America, Camden 8, N. J. (1961), 205 p., 6" x 9", \$3.95 postpaid. An alphabetical compilation of special names and short titles used in military electronic systems, with brief descriptions. AZON, CONSOLAN, LORAN-C, MIDOT, HERALD and SOFAR are examples.

FOR MORE INFORMATION CIRCLE 209 ON READER-SERVICE CARD

ELECTRONIC EQUIPMENT RELIABILITY, by G. W. A. Dummer and N. Griffin, (1961) John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 267 p., 5 1/2 x 8 1/2", \$7.50. Factors affecting reliability of electronic equipment, typical standard vacuum tube circuits, testing and human engineering are included. British terms and notations are used and solid-state active elements only briefly mentioned.

FOR MORE INFORMATION CIRCLE 210 ON READER-SERVICE CARD

HERE'S ONE WAY TO GET WORK DONE WHEN WIRE-WOUND POT FAILURES OCCUR...



SUPERVISOR (A) SEES CHIEF ENGINEER LEAVE HIS DESK TO CHASE DOWN ANOTHER WIRE-WOUND POT FAILURE PROBLEM, CRIES INTO FUNNEL (B), TEARS RUN THROUGH TUBE (C) ONTO JEWELER'S SCALE (D), CAUSING END OF BAR TO PRESS AGAINST SMALL BELLOWS (E), WHICH BLOWS AIR AND CAUSES ARTIFICIAL BIRD (F) TO FLY THROUGH AIR. OFFICE CAT (G), JUMPS ON TREADMILL TO REACH BIRD AND TURNS PULLEY WHEEL (H). ARM (I) BEGINS TO GRASP WILDLY TO PULL IDEAS OUT OF THIN AIR [IN EMERGENCIES, ARM GRASPS AT STRAWS PROVIDED (J)]. ORIGINAL IDEAS DEVELOP FURTHER IN TRAY (M). DESIGN RECEIVES SUPERVISOR'S APPROVAL STAMP (L), PASSES INTO HOPPER (N), MIXES WITH CEMENT, WATER AND GRAVEL, AND EMERGES IN CONCRETE FORM (O). NOTE: MACHINE REACHES EFFICIENCY OF 87.326% IF OFFICE CAT IS KEPT HUNGRY.

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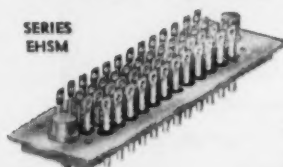
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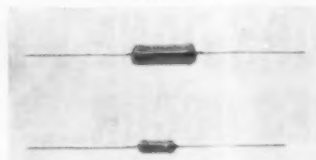
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CIRCLE 80 ON READER-SERVICE CARD

RESISTORS



New Greenohm "V" vitreous wire-wound Resistors with axial leads are available in 3, 5, and 10 watts (Series VC3D, VC5E, VC10F, respectively). Standard resistance tolerance is $\pm 5\%$ for 1 ohm and higher, $\pm 10\%$ for values below 1 ohm.—*Distributor Sales Div., Clarostat Mfg. Co., Inc., Dover, N. H.*

CIRCLE 211 ON READER-SERVICE CARD

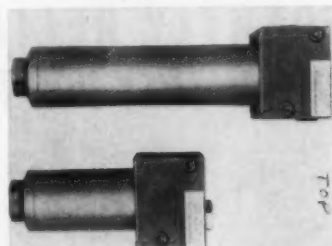
PRECISION CURRENT SOURCE



New Model CS-309A Precision Current Source provides 12 currents of positive or negative polarity from 1 ma to 3 milli-microamperes with 1% accuracy. Uses 1.34-v mercury cell combined with precision resistors. Calibrates current measuring instruments with relatively low input impedance.—*Elcor, Inc., Falls Church, Va.*

CIRCLE 212 ON READER-SERVICE CARD

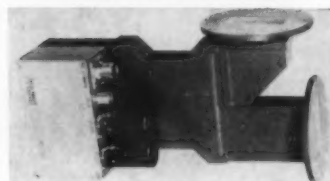
SERVOFILTERS



New Servofilters give either 10 or 20-gpm flows using a single size filter element of either 5 or 25 micron rating. The 10-gpm filter uses one cartridge, 20-gpm filter uses two. Filters have 3000-psi pressure rating and may be used with standard hydraulic oils, MIL-O-5606 oils, and phosphate ester base oils.—*Boonshaft and Fuchs Inc., Hatboro Industrial Park, Hatboro, Pa.*

CIRCLE 213 ON READER-SERVICE CARD

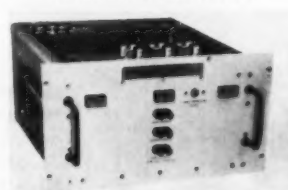
MIXER-PREAMP UNIT



New MDL Model 187MB-360F1 integrated Mixer-Preamplifier (5.15 to 5.85 kmc) serves as low-noise, wide-band downconverter for maser and parametric RF amplifiers. Noise figure less than 7 db, minimum gain of 25 db.—*Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.*

CIRCLE 214 ON READER-SERVICE CARD

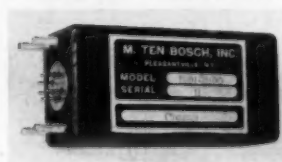
POWER SUPPLIES



New Model 836-001 rack-mounted power supply provides regulated 28-v dc power to third stage nozzle control unit for Minuteman. Electrical characteristics: ac input 120-v line to neutral, 208-v line to line $\pm 10\%$, 3-phase, ac, 4-wire, 60 cps ± 1 ; dc input 28-v, 1 amp required at 28 v; dc output 0 to 80 amp at 28-v. Also new Model 842-001 rack-mounted Power Conversion Unit supplies 28-v dc power to transducer excitation unit, tracking transponder unit and airborne FM/FM units of Minuteman Instrumentation System.—*Western Design Div. of U.S. Industries, Inc., Goleta, Calif.*

CIRCLE 215 ON READER-SERVICE CARD

CHOPPER AMPLIFIER



New Chopper Amplifier Model 1801-0100 ("Champ") converts low level d-c signal to proportionate 400-cps signal at higher power level, uses 28-v dc input at 3 ma with a-c reference voltage of 115 v, 400 cps 3 ma. Nominal input impedance of 5000 ohms; range of values available. Linear range 0 to ± 1 -v dc; allowable range 0 to ± 30 -v dc; output frequency 380-420 cps; output voltage 600-mv rms max into 10,000-ohm load.—*M. Ten Bosch, Inc., 80 Wheeler Ave., Pleasantville, N. Y.*

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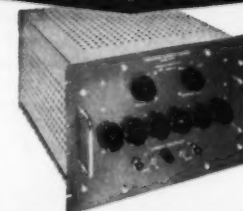
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► Programmable

For testing and measurement of gyros, transistors, diodes, clutches, solenoids, meters, other current sensitive devices.

- Current Range is 0.1 μ a to 150 ma with 6 decade multiplier
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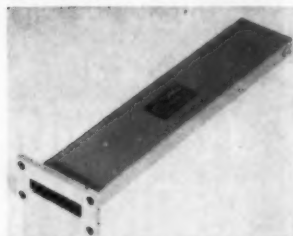
NORTH HILLS
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Glen Cove, Long Island, New York

CIRCLE 82 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

BROADBAND TERMINATION

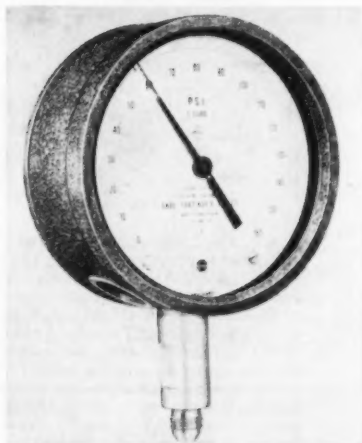


New 6" long, cast aluminum Half-X Broadband Termination for 0.900" x 0.200" ID wave-guide has VSWR less than 1.03:1 from 8.2—12.4 kmc. Max power dissipation is 1-w average, suitable for most low power design measurements and production testing.

—Turbo Machine Co., Lansdale, Pa.

CIRCLE 217 ON READER-SERVICE CARD

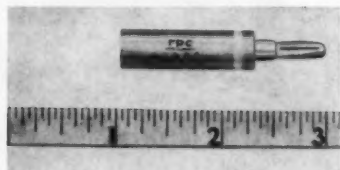
TEST GAGE



New temp-compensated test gage maintains accuracies of $\pm 0.25\%$ at room temp and $\pm 0.375\%$ from -40° to 125°F in pressure ranges of 0-160 and 0-600 psi; $\pm 0.50\%$ at room and $\pm 0.75\%$ from -40° to 125°F from 0-5,000 and 0-10,000 psi. Uses Ni-Span C high nickel alloy bourdon tube.—Meets mil specs.—Gauge Div., American Machine & Metals, Inc., Sellersville, Pa.

CIRCLE 218 ON READER-SERVICE CARD

PLUG-IN RESISTOR



New rpe Plug-in Resistor with range from 1K to 1 megohm is offered in 1K, 10K, 100K and 1 megohm values. Power dissipation is $\frac{1}{4}$ watt at 60°C ; standard tolerance, 0.1%.—Resistance Products Co., 914 S. 13 St., Harrisburg, Pa.

CIRCLE 219 ON READER-SERVICE CARD

REFRIGERATION COMPRESSOR



New Taskline Compressor features internal cooling system that permits unit to be hermetically sealed. Compressed Freon gas circulates through coaxially-mounted motor and compressor elements. Available in 6 models from $\frac{1}{4}$ to 4 hp, operates at 3600 rpm, meets mil specs requiring system design rating for 125°F ambient temp operating conditions.—Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.

CIRCLE 220 ON READER-SERVICE CARD

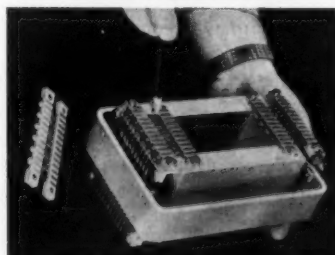
BACKWARD-WAVE OSCILLATOR



New Ku-Band permanent-magnet Model 326H Backward-Wave Oscillator has 10-mw minimum output over 12.4-18 kmc band with power rising to 65 mw in center of band. Requires no external cooling, with all electrodes isolated from each other and from case. Features low spurious output and narrow spectrum width.—Microwave Tube Div., Hughes Aircraft Co., 11105 Anza Ave., Los Angeles 45, Calif.

CIRCLE 221 ON READER-SERVICE CARD

CABLE ISOLATOR



New Cable Isolator consists of prestressed twisted strands of cable mounted between two metal retainers; controls vibration and shock in presence of high steady-state loads; does not bottom out. Isolators joined and mounted together form space-saving isolating system. Allows tuning isolation system after installation for optimum performance or changed field requirements.—Aeroflex Laboratories, Inc., 34-06 Skillman Ave., Long Island City 1, N. Y.

CIRCLE 222 ON READER-SERVICE CARD

READOUT OF THIS WORLD

DOWN-TO-EARTH FACTS

A three year test proves that our ultra long life NIXIE® Indicator Tubes have 100 times longer life than any other electronic readout.

Consider this, then add the factors of lowest cost, smallest size, lightest weight, lowest power, most easily read, and we feel you will agree NIXIE tubes are, beyond the shadow of a doubt, the finest in-line readouts ever made.

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SUPER-DRY Air...

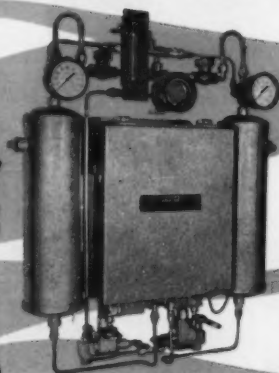
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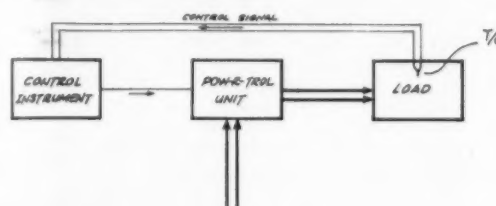
Heat-Les Dryers • Heat-reactivated Dryers
Thermocouples and Thermowells

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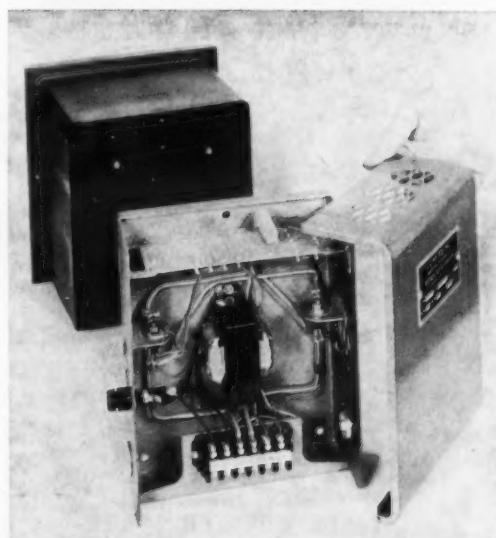
CIRCLE 84 ON READER-SERVICE CARD

Control of Power Output by a Power Follower

Multi-zone diffusion furnaces, alloying furnaces, etc. require a large number of control zones for complex temperature profiles. A constant-phase control unit (using silicon control rectifiers) provides high power factor and microsecond response for such complex temperature control.



pHayes-master Control System.



pHayes-master (Formerly named the Pow-R-Trol) Unit.

Silicon control rectifiers are less bulky and costly than vacuum tubes, magamps, saturable core reactors, etc. Space savings up to 75% can be realized. Silicon rectifiers can be triggered manually, or by a millivolt control signal from a temperature, pH, or other control instrument. Standard capacities are 10, 15 and 70 amps for 115 or 230 volts, single phase or three phase. (From news release by C. I. Hayes, Inc., 924 Wellington Ave., Cranston 10, R. I.)

FOR MORE INFORMATION CIRCLE 223 ON READER-SERVICE CARD

WESCON SHOW ISSUE

July-August MSD offers triple value to advertisers: Special coverage of Resistive Components; it's the Wescon and pre-ISA Shows issue; and is a Fosdick "Ad Readership Study" issue.

Ad space open 'til August 1. Contact any MSD rep—see inside front cover.

NEW DE-LINE
annunciator has
70% MORE
ENGRAVING
AREA for more
precise
trouble legends

PA-102
LOW PRESSURE
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LUBRICATING
OIL



Scam De-Line annunciators, your systems' sentry, now offers the new MAGNA-PLAC nameplate which provides 70% more engraving area.

The MAGNA-PLAC nameplate gives the engineer increased space to more accurately describe condition variations or to employ larger characters for greater visibility. It is interchangeable with standard Scam nameplates and optionally available without extra charge.

Other De-Line features include side or stack mounting for practical, economical system expansion; a single plug-in relay for both normally open or normally closed contacts; and sequence options after installation.

Yes, continuous product improvements such as MAGNA-PLAC, flexible application, ruggedness and reliability are what make De-Line the engineer's annunciator.

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CIRCLE 85 ON READER-SERVICE CARD
MILITARY SYSTEMS DESIGN

LABORATORY ACCURACY • MILITARY RUGGEDNESS

IMPEDANCE BRIDGE

MODEL
ZB-1



★ AC and DC
Resistance

★ Inductance
and Storage
Factor

★ Capacitance
and Dissipation Factor

The Model ZB-1 provides for measurement of AC and DC resistance, inductance and storage factor, capacitance and dissipation factor. It is a laboratory instrument in accuracy, range and versatility in addition to being compact, portable and ruggedly constructed. It meets all the requirements of the Military Impedance Bridge Model AN/URM-90.

SPECIFICATIONS

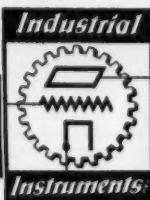
RANGE:

RESISTANCE 0.001 ohm to 11 megohms A-C or D-C (8 ranges)
CAPACITANCE 1 uuf to 1100 uf (7 ranges)
INDUCTANCE 1 uh to 1100 h (7 ranges)
D 0.001 to 1.0 at 1 KC } Provision for external
Q 0.02 to 1000 at 1 KC } extension

ACCURACY

RESISTANCE	0.1 ohm range	±0.35%	INDUCTANCE	100 uh and below	±2 uh
	100 K ohm range	±0.2%		10 h and above	±10%
	All other	±0.15%		All other	±1%
CAPACITANCE	100 uuf and below	±2 uuf	D FACTOR		±(5%+0.0025)
	100 uuf range (above		Q FACTOR	to 10 hy	±(5%+0.0025)
	100 uuf)	±2%		at 100 hy	±(5%+0.015)
	All other	±0.5%		at 1000 hy	±(5%+0.055)

INTERNAL OSCILLATOR FREQUENCY..... 1 KC ±1%
INTERNAL D-C SUPPLY..... 10 V at 250 ma. (D-C Low)
1200 V at 10 ma. (D-C High)
INTERNAL DETECTOR Response flat or selective at 1 KC; sensitivity control provided.
POWER LINE 115 volts, 50-1000 cycles, 18 watts.
DIMENSIONS 10 1/4" x 11 1/4" x 11 1/4" overall with cover.
WEIGHT 21 lbs.
ACCESSORIES SUPPLIED Set of red and black test leads (19" long) with 2 alligator clips.



For complete technical
specifications write . . .

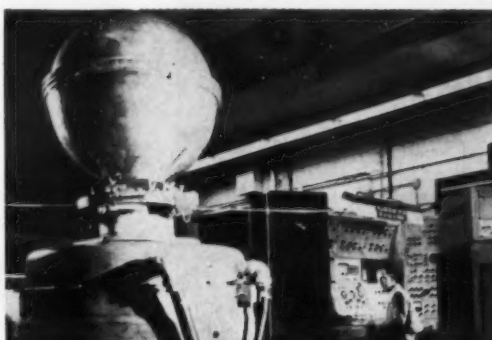
Industrial Instruments
89 COMMERCE ROAD, CEDAR GROVE, N. J.

CIRCLE 86 ON READER-SERVICE CARD

January-February, 1961

Echo Satellite "Test Flown" in NASA Lab

A 26 1/2" magnesium sphere containing an Echo satellite, a micro-thin aluminum-coated plastic balloon, is shown being vibration tested at the Langley Research Center of the National Aeronautical and Space Administration.



The satellite, more than 157' long when laid out on a work table, has been compactly folded inside the container. The deflated balloon is designed to be rocketed into orbit, ejected from the container and automatically inflated into a 100'-diameter sphere. It is used as a reflector of radio waves in passive communications experiments and in studying the characteristics of space.

Model C125 electrodynamic vibration exciter used here can produce acceleration levels to 100g. Vibration tests, simulating in-service conditions encountered during a trip into orbit, play an important part in preflight missile and satellite programs.—MB Electronics, Div. Textron Electronics, Inc., 781 Whalley Ave., New Haven 8, Conn.

FOR MORE INFORMATION CIRCLE 224 ON READER-SERVICE CARD

Sliding Piston Trimmer



New type of variable trimmer capacitor with sliding piston is being used with cam driven mechanisms for fine tuning action and long life. Spring fingers, rhodium plated for long life and low contact resistance, achieve contact between piston and panel mount bushing. Available in all capacitance values from 0.6 to 90 picofarads in glass or quartz dielectric, in standard, differential, split stator, open or sealed construction.—JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N. Y.

FOR MORE INFORMATION CIRCLE 225 ON READER-SERVICE CARD

EICO 1961

KITS AND WIRED

- STEREO
- AND MONO
- HIGH FIDELITY
- TEST INSTRUMENTS
- HOME EQUIPMENT
- CITIZEN TRANSCEIVERS
- RADIOS

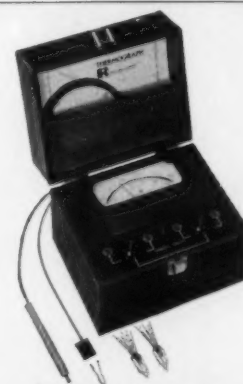
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FOR FAST, SIMPLIFIED
TEMPERATURE MEASUREMENTS..

The RESCON THERMAL TEST SET

A compact, portable unit for obtaining temperature measurements in electronic equipment — from the individual component to the package itself. Applications include: transistors, diodes, tubes, transformers, micro-miniature circuits, etc.
 Direct readings . . . no calibrations . . . rugged construction.

RESCON
ELECTRONICS CORPORATIONS
151 Bear Hill Road, Waltham 54, Mass.
TWINBROOK 9-8600

Designers and Manufacturers of Electronic Test Equipment

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DEPENDABILITY
is a prime
requisite



PRESS-FIT[®] TEFLON[®] TERMINALS

Sealectro Press-Fit Teflon Insulated Terminals, Feed-Throughs, and Test Jacks assure maximum dependability under all operational conditions. Designs resulting from unparalleled experience, careful fabrication from the finest materials, and precise inspection combine to make Sealectro Press-Fit units first choice for quality and value...

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TEFLON TERMINALS
CON-HEX[®]
RF CONNECTORS
British Branch: Sealectro Corporation,
Hersham Factory Estate, Lyon Road,
Walton-on-Thames, Surrey, England.

CIRCLE 89 ON READER-SERVICE CARD

Micro-Miniature Multipin Connector

The end result of a two-year design and market survey study—a new line of multiconductor connectors encompassing precision, micro-miniature, power, coaxial, and combination power-coax contacts—has been introduced by Microdot Inc., South Pasadena, Calif. Introduced particularly for missile and other advanced military applications at the 1960 WESCON Show, the line consists of three basic shell sizes, ranging from 3/4" diameter accommodating 19 22-AWG power contacts or 9 coaxial contacts to 1 1/8" diameter enclosing 61 power or 19 coaxial contacts.



FIG. 1. MICRO-MINIATURE MULTIPIN connector 3/4" diameter carries up to 19 5-ampere contacts.



FIG. 2. DIS-ASSEMBLED CONNECTOR shows simplicity of design and interchangeability of parts.

With 5 ampere capacity and 750 working voltage determining the minimum size of the insulator and the low contact resistance and high insulation resistance determining the materials, new design concepts were necessarily limited.

Often the engineer wishes to design hot circuits to both the plug and receptacle sides of the connector, yet without risking the accidental shorting of unprotected hot, male plug contacts. The new Microdot system allows the setting up of a hermaphroditic insert design, with a mixture of male and female contacts in both the plug and the receptacle. This hermaphroditic insert layout also reduces the need for "clocking."

Contacts are readily assembled on conductors, using crimping methods or solder. These contacts are designed for easy insertion in the insulating body and for quick disassembly to delete or replace old circuits or to add new circuits.

Supplied either in "kit" form for assembly by the user, or in cable assemblies custom-built to customer specifications, the new Microdot Multipin Connectors allow on-the-spot revisions of circuit designs and adaptations to changing requirements. Both fly-away and ground support requirements are met and a minimum stock of maintenance spares is sufficient to support all sizes and conformations of connectors.

FOR MORE INFORMATION CIRCLE 226 ON READER-SERVICE CARD



THE NEWEST ADDITION TO THE **PREM-O-RAK[®]** MODULAR CONSOLE SYSTEM **SLOPED FRONT CONSOLE CABINET**

- Tops of front and rear are rounded.
- Designed for multiple installations.
- Made of No. 14 gauge steel and welded throughout.
- Sloped front is 19° from vertical.
- Panel mounting angles made of No. 12 gauge steel and tapped 10/32 on E.I.A. spacings; front and rear vertical angles adjustable to any position.
- Ball cornered end panels.

- Frame finished in gray hammertone. End panels in brown hammertone.



Cat. No. FS-1001

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5810 Smart Ave., Montreal

CIRCLE 90 ON READER-SERVICE CARD
MILITARY SYSTEMS DESIGN

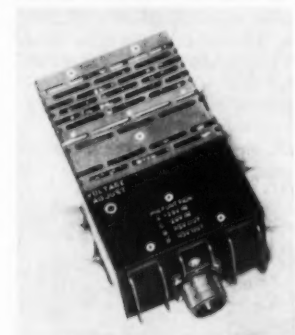
PLASTIC POTENTIOMETER



New Model 3010 all-plastic Trimpot Potentiometer features humidity resistance without encapsulation. Specs: 10 to 100K ohms resistance, 175°C max operating temp, 70-ppm max temp coefficient, 1.0 watt (at 70°C) power rating.—Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

CIRCLE 227 ON READER-SERVICE CARD

SOLID STATE INVERTER



New solid-state DC-to-AC Inverter weighs 3.7 lb, is 2.76" x 3.80" x 5.90". Operates on nominal 28-v d-c input with output of 115 v, 400 cycles (sine wave), single phase 1700 VA. Full input range, 22-32 v dc; input current (max), 5.5 amp at 22 v and full 100-VA output.—Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif.

CIRCLE 228 ON READER-SERVICE CARD

LONG-STROKE POTENTIOMETERS

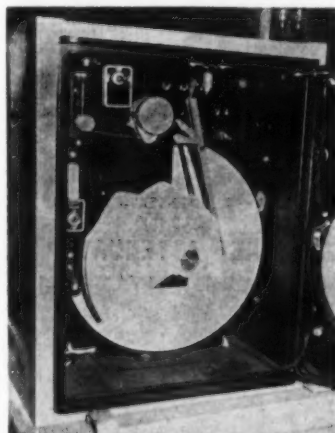


New Model L 111 Linear Motion Potentiometers provide outputs without amplification as great as 350 v/in of shaft movement, sensitivity of 5 millionths of an inch over any stroke up to 30". Units meet mil specs, have life in excess of 10 million strokes, depending on circuitry.—Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.

CIRCLE 229 ON READER-SERVICE CARD

Programmed Thermal Chambers Facilitate Timed Component Tests

Accelerated life tests, thermal shock and hot-cold test cycles are called for in many product specifications. The Hi-Low line of temperature test chambers (Electric Hotpack Co., Cottman Ave. at Melrose, Phila. 35, Pa.) uses a Honeywell Program Recorder-Controller, featuring cam programming of a heat source and a cold source (CO₂) to produce any desired program from -100°F to 400°F, accurate to within 1°F. Inner chamber dimensions range from 10" x 7" x 7" to 27.5 cubic feet of test space.

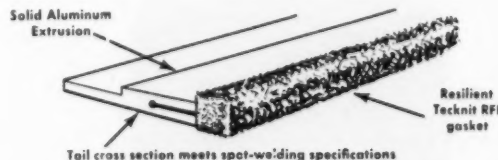


ONE CAM CONTROLS HEAT, the other the cold. Direct discharge of liquid CO₂ circulated within the chamber by a high velocity blower system, enables shock cooling of the test volume to the lowest temperature within seconds. Either bottled or refrigerated storage tank CO₂ sources can be used.

FOR MORE INFORMATION CIRCLE 230 ON READER-SERVICE CARD

Knitted RFI Gaskets

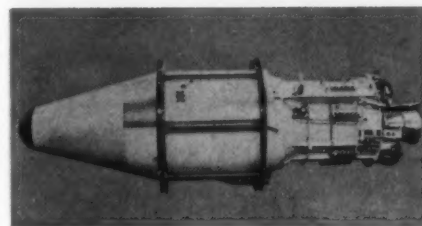
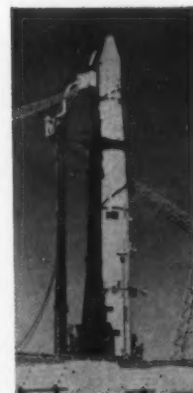
Teckstrip, a resilient Radio Frequency Interference gasket combined with a solid aluminum mounting strip, solves the old and difficult problem of attaching RFI shielding strips. Available either as standard strip, custom fabricated pieces, or complete frames



... The newest Teckstrip is the spot-weldable version shown. It meets the width-to-thickness specifications for aluminum spot-welding. Teckstrip advantages: direct attachment, cuts installation costs, accurate positioning, positive compression stop, adds structural strength, well-designed look... (From series of 2 and 4-page Bulletins RF-1 to RF-10, Technical Wire Products Inc., 48 Brown Ave., Springfield, N. J.)

FOR THIS LITERATURE CIRCLE 231 ON READER-SERVICE CARD

FOR THE VITAL DISCOVERER PROGRAM



LOCKHEED
USES



DORSETT telemetry components

Telemetry components designed and precision built by Dorsett Electronics will be aboard specially instrumented Lockheed Agena Space Vehicles to be flown in the Discoverer Satellite Program.

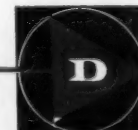
Lockheed Missile and Space Division is the latest in a long list of missile and satellite prime contractors to buy Dorsett telemetering components for advanced aerospace research programs.

Typical of the telemetering equipment originating at Dorsett Electronics is the Model O-8 subcarrier oscillator. Requiring only 6 volts at .7 (nominal) milliamperes primary power, this all-silicon transistor unit provides excellent temperature stability for drift-free data. With its compact packaging, the Model O-8 is ideal when electrical power is limited, space and weight are critical, and environmental extremes are to be encountered.

For more information on the products and capabilities of this fast growing team of telemetering specialists or on technical career opportunities, write today!

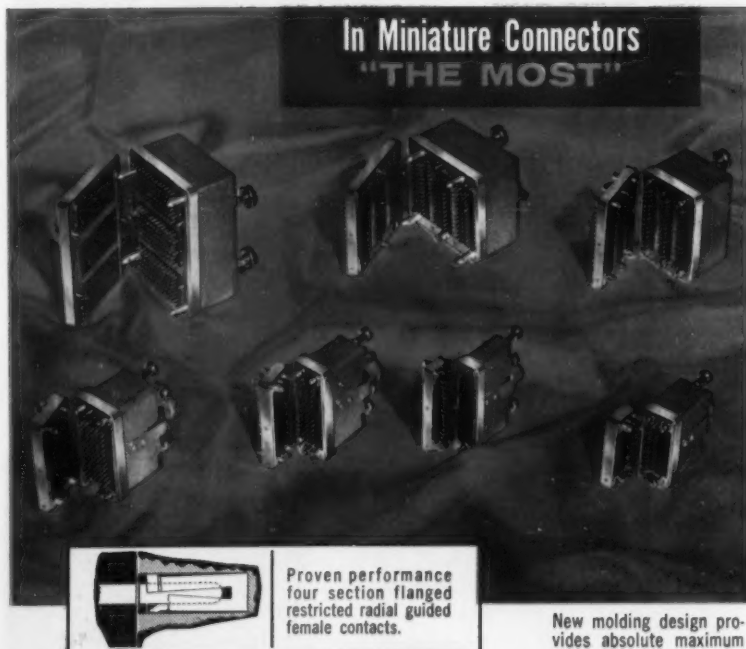
DORSETT ELECTRONICS

LABORATORIES, INC.



119 WEST BOYD • NORMAN, OKLAHOMA • JE 4-3750
CIRCLE 91 ON READER-SERVICE CARD

In Miniature Connectors "THE MOST"



Proven performance
four section flanged
restricted radial guided
female contacts.

New molding design provides absolute maximum torque resistance for screw lock operation.

...MEANS U.S. COMPONENTS F.B.I. SERIES

The most shock and vibration resistance—*Patented Floating Body Isolation guarantees vibra-shock protection and operation by complete separation of electrical contact body from mechanical elements.

The most comprehensive line—Single units have 34-41-50-75 contacts. Modular multiple connectors have 123-150-225 contacts. Other configurations upon request.

The most flexibility in body molding compounds—Connector bodies are supplied in glass fibre diallyl phthalates in various compositions and colors.

The most methods of attaching leads—wire solder, solderless or turret-type terminals.

The most in precision screw lock connectors.

The most in quality control—Inspection and testing applied on a 100% basis. Meet or surpass all applicable MIL specifications.

FBI SERIES	NUMBER OF CONTACTS			
MI-BSL Miniature Screw Lock	34	41	50	75
MI-BMSL Miniature Modular Screw Lock	123	150	225	

SPECIFICATIONS

Wire size #20 AWG wire
Voltage breakdown between contacts (with connector engaged—sea level—normal humidity)..... 2800 V. A.C. RMS
Current rating 7.5 amps.
Hoods and brackets aluminum anodized

Also available in Hoodless Knob Type
U.S. Pat. Nos. 2,761,108; 2,845,603; 2,845,604
and additional Patents Pending.

Your specific inquiry will receive immediate attention.



U. S. COMPONENTS, INC.
1320 Zerega Ave., New York 62, N. Y. TAlmadge 4-1600

CIRCLE 92 ON READER-SERVICE CARD

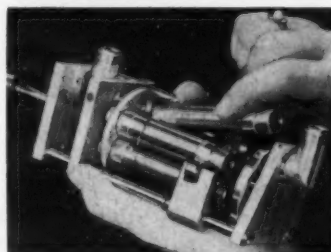
3-OZ ACCELEROMETER



New LA-800 non-pendulous, constant-damped linear Accelerometer weighs less than 3 oz. Features high-G range with low natural frequency by use of variable-area fluid couplings. Operates at peak efficiency within -65° to 250°F , withstands shock to 100 G's and vibration to 2,000 cps at 30 G's, has 4-to-25-volt output depending on excitation frequency, has high signal-to-noise ratio.—Boston Div., Minneapolis-Honeywell Regulator Co., 40 Life St., Boston 33, Mass.

CIRCLE 232 ON READER-SERVICE CARD

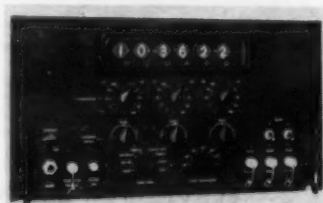
UHF TURRET ATTENUATOR



New step-type Turret Attenuators permit quick change of db combinations compatible to individual system requirements. Removing 3 set screws allows pad retainer ring to move forward for rearrangement of pads. Turrets available in combination of values from 0.1-60 db in 0.1-db increments. Bulletin AT-3.—Stoddard Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

CIRCLE 233 ON READER-SERVICE CARD

1-MC COUNTER-TIMER



New Model 1036 Programmable 1-Mc Counter-Timer, designed to MIL-Spec, is ruggedized for field consoles of Automatic Checkout systems. Measures frequency, period, time interval, frequency ratio and phase to accuracies of 1 ppm.—Syston Corp., 950 Galindo St., Concord, Calif.

CIRCLE 234 ON READER-SERVICE CARD

STEPPER MOTOR

New Series 18190 Stepper Motor operates with windings continuously energized in static condition or pulsed at rates to 2400 steps/min, is suited to high speed stepping applications



where pulse power is limited. Withstands 100-g shock for 7 ms, and 10-g acceleration; operates from 85° to -54°C . Requires 12.5 msec (min), delivers 80 pulses/sec. Motor is unidirectional; small size permits two units to be combined with differential for bi-directional operation or algebraic addition.—A. W. Haydon Co., Waterbury, Conn.

CIRCLE 235 ON READER-SERVICE CARD

ROTARY/TILT TABLES



New Rotary and Rotary Tilting Tables offer indexing to ± 5 sec even under heavy loads. Rotary Tables in 7 sizes (10"-40" dia), 24" and 32" models available with direct optical setting to 1 sec. Tilting Tables in 6 sizes (10"-32").—International Machine & Tool Corp., Warwick Industrial Park, Providence 5, R. I.

CIRCLE 236 ON READER-SERVICE CARD

MAGNETIC STORAGE DRUM



New low-cost high-speed Magnetic Storage Drum, capable of storing 100,000 binary bits of computer information, meets the exacting specifications for buffer storage to magnetic tape.—Farrington Mfg. Co., Needham Height 94, Mass.

CIRCLE 237 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

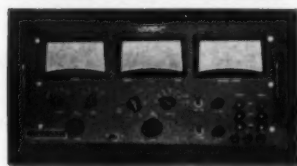
POWER SUPPLY



New Voltage and Current Regulated T50-750 lab supply furnishes 0-50 v dc at 0-750 ma, provides constant regulation better than 0.05%; voltage ripple less than 0.5 mv, current ripple less than 0.01%. Has adjustable current limiting short circuit protection, assuring control of output current even under short circuit conditions.—Trygon Electronics, Inc., 111 Pleasant Ave., Roosevelt, L. I., N. Y.

CIRCLE 238 ON READER-SERVICE CARD

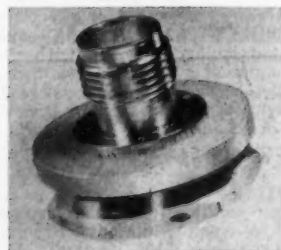
TRANSISTOR TEST SET



New Transistor Test Set Model TTS-100 measures dc characteristics of power transistors: leakage currents, dc gain, transconductance, input impedance, etc. Punch-through voltage determined without damaging transistor.—Command Systems, Inc., 1135 N. Stanford Ave., Los Angeles 59, Calif.

CIRCLE 239 ON READER-SERVICE CARD

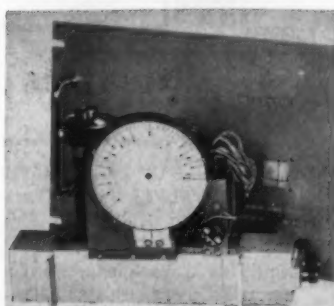
ADAPTERS



New TNC and TM Insulating Adapters allow use of coaxial instead of triaxial connectors. Units insulate TNC and TM connectors from mounting panel or isolate coaxial ground line from panel.—General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass.

CIRCLE 240 ON READER-SERVICE CARD

C-BAND ATTENUATOR



New direct-reading C-Band Attenuator has coaxial Type N connectors, is motor actuated from 0-100 db in less than 50 sec. Attenuated by inserting 2 glass cards transversely into waveguide; accurate to 0.1 db or $\pm 1\%$ of dial reading at calibration frequency; VSWR under 1.5 from 5.0-5.8 kmc (under 1.1 at one frequency); insertion loss 1.0 db max.—Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif.

CIRCLE 241 ON READER-SERVICE CARD

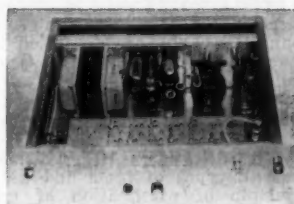
COAXIAL SWITCHES



New Type W miniature Coaxial Switches use 28-v dc solenoids, include 5.5-oz SPDT (right) and 10-oz Transfer switches available with Type N or TNC connectors. Typical RF characteristics at 2 kmc: 1.15 VSWR, 0.2-db insertion loss, 50-db crosstalk.—Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif.

CIRCLE 242 ON READER-SERVICE CARD

BROADBAND AMPLIFIER



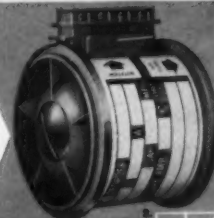
New Model HFW-8(A)-49100 Broadband Amplifier covers 490 to 1000 Mc, uses synchronously tuned stages with planar low-noise triodes as amplifiers. Regulated anode and heater power supply provided. Amplifier gain greater than 20 db; noise figure max 10 db; VSWR input and output 1.75.—Applied Research Inc., 76 S. Bayles Ave., Port Washington, N. Y.

CIRCLE 243 ON READER-SERVICE CARD

AXIMAX MINIATURE 400CPS FANS

1 13/32"
4 OZS.

AXIMAX 1
12 to 23 CFM
11,400 to
22,500 RPM

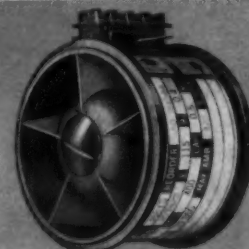


- Extremely compact and lightweight—1 13/32" x 1 1/4", 4 ozs.
- 115 or 200 VAC, 1 ϕ or 3 ϕ , 400 cps.
- Airflow reversible.
- Built to Military Specifications.



1 13/32"
4 1/2 OZS.

AXIMAX 2
24 to 60 CFM
8,000 to
20,000 RPM



- Size: 2" x 1 1/2". Weight: 4 1/2 ozs.
- 115 or 200 VAC, 320 through 1800 cps, 1 ϕ or 3 ϕ
- High altitude (Altivar)® and high density designs available.
- Airflow reversible.
- Built to Military Specifications.



2 5/8"
14 OZS.

AXIMAX 3
70 to 165 CFM
9,000 to
22,000 RPM



- Size: 3 1/4" x 2 3/4". Weight: 14 ozs.
- 115 or 200 VAC, 400 and other cps, 1 ϕ or 3 ϕ .
- High altitude (Altivar)® and high density designs available.
- Airflow reversible.
- Built to Military Specifications.



Appropriate cam-locking mounting clamps are available from Rotron for servo-mount Aximax fans.



Write for Complete
Technical Details,
or Submit Your
Cooling Problems for
Recommendations...



ROTRON
MANUFACTURING CO., INC.
WOODSTOCK, NEW YORK

"AXIMAX" is a registered trademark of Rotron Manufacturing Co., Inc.
CIRCLE 93 ON READER-SERVICE CARD



Switch to **Kulka** TOGGLE SWITCHES

Designed and built for long, rugged, dependable service, Kulka Toggle Switches provide positive, precise switching for electronic and electrical circuits. Made to Joint Army and Navy Specifications JAN-S-23, MIL-S-21195, MIL-S-6745 and MIL-S-3950A. Available in SPST, SPDT, DPST and DPDT types, DC and AC up to 1600 cps.

NOW ... YOUR CHOICE OF TERMINALS

SCREW —
SOLDER —
OR TAB

Now, specify the terminal type best suited to your needs. Standard screw terminal, hole-through solder type, or male tab for accepting Burndy, AMP or Kent female slip-on connectors.

WRITE FOR COMPLETE DETAILS

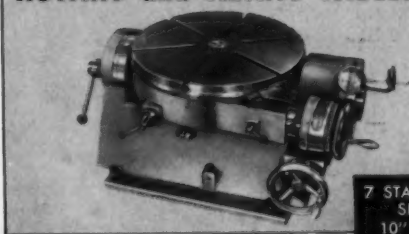
KULKA ELECTRIC CORP.

633-643 SO. FULTON AVENUE, MOUNT VERNON, N. Y.
CIRCLE 94 ON READER-SERVICE CARD

Precision: ROTARY and TILTING TABLES

Guaranteed Quality
IMTCO

We carry the most complete line of Rotary Tables such as: Standard Rotary Tables, powered Tables, with automatic cycling optically controlled. Specials on request at a truly modest price!



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SIZES
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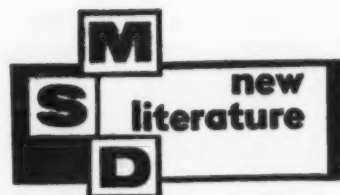
CIRCLE 95 ON READER-SERVICE CARD

SPECIAL FOR 1961 . . .

MSD subjects for editorial emphasis will include:

- Logic Elements and Micro Relays (March-April)
- Infrared and Solar Cell Devices (May-June)
- Resistive Components (July-August)
- Reactive Components (September-October)
- Gyros and Stable Platforms (November-December)

For results, advertise in every issue. Contact any MSD rep—see inside front cover for addresses.



PRECISION VALVES for military requirements are tabulated and described in 2-page Check-Off Chart.—James, Pond & Clark, Inc., 2181 E. Foothill Blvd., Pasadena, Calif.

CIRCLE 244 ON READER-SERVICE CARD

GYRO having two-degrees-of-freedom and driven by hot gas provides displacement reference for missiles during short-duration flights and is described in 4-page brochure.—Instrument Div., Lear, Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

CIRCLE 245 ON READER-SERVICE CARD

FREE SPACE ROOMS for testing radar antennas, their design problems, solutions, and specification pitfalls are analyzed in 18-page report.—McMillan Industrial Corp., Electronic Components Div., Brownville Ave., Ipswich, Mass.

CIRCLE 246 ON READER-SERVICE CARD

LINT-FREE UNIFORMS for precision assembly operations and dust control areas are illustrated and described in 6-page brochure.—Angelica Uniform Co., 1427 Olive St., St. Louis 3, Mo.

CIRCLE 247 ON READER-SERVICE CARD

SUBMINIATURE-SWITCHES, including high-temp, sealed, environment-free, and MIL-Spec types as well as phenolic-cased, push-button, toggle, and integral-actuator switches, are detailed in 16-page Catalog 20-1.—Unimax Switch Div., W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

CIRCLE 248 ON READER-SERVICE CARD

SWITCHES (miniature lighted push-button 302PB-1-T Series) are described in 2-page Data Sheet 182.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

CIRCLE 249 ON READER-SERVICE CARD

FLEXIBLE HOSES used in cooling applications as flexible conduits, blower connections, etc. are described in 12-page Bulletin 605.—Flexaust Co., Div., Callahan Mining Corp., 100 Park Ave. New York 17, N. Y.

CIRCLE 250 ON READER-SERVICE CARD

RADIATION FUEL GAGE, which measures all types of fuels and uses the principle of attenuation of gamma radiation by matter to indicate the fuel quantity, is described in 6-page brochure.—Atomics International, Div. North American Aviation, Inc., Canoga Park, Calif.

CIRCLE 251 ON READER-SERVICE CARD

TELEMETRY COMPONENTS. Series of ten 2-page data sheets describe types of multicoders, commutators, and amplifiers.—Applied Electronics Corp. of New Jersey, 22 Center St., Metuchen, N. J.

CIRCLE 252 ON READER-SERVICE CARD

PRECISION POTENTIOMETERS and turns counting dials are described in 6-page brochure.—Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif.

CIRCLE 253 ON READER-SERVICE CARD

ANGLE INDICATOR using double-speed transmission and accurate to ± 6 minutes (single speed) or ± 15 sec (two speed) is presented in 2-page reference sheet.—Kearfott Div., General Precision, Inc., Little Falls, N. J.

CIRCLE 254 ON READER-SERVICE CARD

INSTRUMENTATION CHAIN for missile-range instrumentation, including vehicle tracking, plotting of tracking data and control of target acquisition equipment is described in 5-page Report 80-350-TC-3.—Computer Systems, Inc., Culver Rd., Monmouth Junction, N. J.

CIRCLE 255 ON READER-SERVICE CARD

MICROWAVE POWER ATTENUATORS Models AT-57 (continuous power rating 10 w) and AT-58 (continuous power rating 15 w) are described in 2-page Bulletin 578.—Empire Devices, Inc., Amsterdam, N. Y.

CIRCLE 256 ON READER-SERVICE CARD

TRANSISTORIZED CHOPPERS ("chopperettes") that exceed mil-spec requirements are described in 4-page Form V383B.—Victory Engineering Corp., Box 373, Union, N. J.

CIRCLE 257 ON READER-SERVICE CARD

COMPLETE CLEAN ROOM SERVICE, including installations and employee training, is described in 4-page bulletin.—Controlled Environment, Inc., 52 Pickering St., Needham 92, Mass.

CIRCLE 258 ON READER-SERVICE CARD

HIGH-Q FIXED INDUCTOR ("Therm-L"), stable from -55° to 375°C is described in 2-page data sheet.—Nytronics, Inc., Essex Electronics Div., 550 Springfield Ave., Berkeley Heights, N. J.

CIRCLE 259 ON READER-SERVICE CARD

600-CHANNEL MULTIPLEXING SYSTEM, Model B910, is described in 8-page brochure.—Lynch Communication Systems, Inc., 695 Bryant St., San Francisco 7, Calif.

CIRCLE 260 ON READER-SERVICE CARD

FAST PULSE TRANSMISSION equipment particularly useful with fast pulse sources is described in 5-page bulletin.—Electrical and Physical Instrument Corp., Engineering Div., 42-19 27 St., Long Island City 1, N. Y.

CIRCLE 261 ON READER-SERVICE CARD

POTENTIOMETERS, 13 leadscrew and wormgear-actuated models, are described in 4-page Summary Brochure 6.—Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

CIRCLE 262 ON READER-SERVICE CARD

GRAPH SHEETS, cross section and profile paper, cloths and films are illustrated and analyzed for best use in 88-page catalog.—Keuffel & Esser Co., Adams & Third Sts., Hoboken, N. J.

CIRCLE 263 ON READER-SERVICE CARD

PULSE WIDTH DISCRIMINATOR Filter R-PWD applicable to pulse and video type electronic systems such as radar, I.F.F., pulse sensory detection, antijamming, etc. is described in 6-page brochure.—Mini-Rad, Inc., 7416-E Varna Ave., North Hollywood, Calif.

CIRCLE 264 ON READER-SERVICE CARD

ULTRASONIC THICKNESS TESTERS (Audigage) measure material thickness nondestructively from one side, are portable, battery-operated; described in 8-page bulletin.—Branson Instruments, Inc., 37 Brown House Rd., Stamford, Conn.

CIRCLE 265 ON READER-SERVICE CARD

MOTOR-RUN CAPACITORS for air conditioning, refrigeration, heating, and general industrial use are described in 2-page Series 55 bulletin.—John E. Fast & Co., 3598 N. Elston Ave., Chicago 18, Ill.

CIRCLE 266 ON READER-SERVICE CARD

MAGNETIC LATCHING RELAY having 10-amp contacts, operating on as little as 100 mw and weighing 1.1 oz is described in Bulletin BR-A.—Babcock Relays, Inc., 1640 Monrovia Ave., Costa Mesa, Calif.

CIRCLE 267 ON READER-SERVICE CARD

C-R STORAGE TUBES. 2-page data sheet details Type H-1027 Tonotron magnetic deflection, 5" direct view storage tube; 4-page data sheet details Type H-1019 Typotron 21" direct view tube.—Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.

CIRCLE 268 ON READER-SERVICE CARD

COAXIAL FILTERS.—4-page brochure describes ganged or individually tuned coaxial resonant cavity devices which operate over various bands of frequency covering 2.1 to 5.9 kmc.—Waveline, Inc., Passaic Ave., Caldwell, N. J.

CIRCLE 269 ON READER-SERVICE CARD

TRANSIT CASES.—8-page Catalog H describes packaging applications of laminated aluminum-to-plywood sandwich material.—Zero Mfg. Co., Burbank, Calif.

CIRCLE 270 ON READER-SERVICE CARD

DIE STAMPED CIRCUITS. how to design with them, and their terminology are presented in 12-page Bulletin D1.—Dytronics, Inc. 115 Main St., Rochester, Mich.

CIRCLE 271 ON READER-SERVICE CARD

SEMICONDUCTORS.—8-page Condensed Catalog 100 presents characteristics and cutaway drawings of silicon diodes and stacks, selenium rectifiers, stacks and cartridge rectifiers.—Semiconductor Div., Syntrol Co., Homer City, Pa.

CIRCLE 272 ON READER-SERVICE CARD

CRYSTAL CASE RELAYS (DPDT) offering several header styles, mountings coil indicators, etc. are presented in 4-page Bulletin 1064.—Union Switch & Signal Div., Westinghouse Air Brake Co., Pittsburgh 18, Pa.

CIRCLE 273 ON READER-SERVICE CARD

GUIDANCE SYSTEM. 28-page brochure describes guidance and control operational and support equipment for use with Air Force's mobile Minuteman missile.—Autonetics, Div. North American Aviation, Inc., 9150 E. Imperial Hwy., Downey, Calif.

CIRCLE 274 ON READER-SERVICE CARD

DIGITAL DELAY GENERATOR. Model 218A, produced to meet requirements for generation of precise delays, has general purpose applications depending on use of plug-in units. 6-page Application Note 48.—Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

CIRCLE 275 ON READER-SERVICE CARD

OSCILLATOR. 2-page Bulletin 201 describes Voltage Controlled Oscillator, Model 1270, which converts low-level voltage input to frequency-modulated signal suitable for magnetic recording or transmission by radio or wire link.—Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif.

CIRCLE 276 ON READER-SERVICE CARD

AC/DC STEREO AMPLIFIERS using output tubes having 100-mamp heaters, Types 34GD5, 50FK5, and 60FX5, are described in 6-page Application Note AN-190.—Commercial Engineering, Electron Tube Div., Harrison, N. J.

CIRCLE 277 ON READER-SERVICE CARD

HYDRAULIC & PNEUMATIC VALVES. rotary pressure switches, precision filters, hydraulic cylinders, and fuel atomizers are described in 8-page brochure.—IMC Magnetics Corp., Marketing Div., 6058 Walker Ave., Maywood, Calif.

CIRCLE 278 ON READER-SERVICE CARD

MAGNETIC COMPONENTS such as wave filters, magnetic amplifiers, molded transformers, etc. are described in 4-page catalog.—Tenco Electronics, Inc., 108 Cummington St., Boston 15, Mass.

CIRCLE 279 ON READER-SERVICE CARD

THERMAL TIME DELAY RELAYS with delay tolerance $\pm 10\%$ are described in 2-page bulletin.—Clairtron Mfg. Co., Box 171, Orange, N. J.

CIRCLE 280 ON READER-SERVICE CARD

MINIATURE BLOWERS. 2-page Bulletin 540 describes VAX-3-BD vaneaxial d-c blowers that produce 65 cfm at 1.6" H₂O.—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.


CIRCLE 281 ON READER-SERVICE CARD

RELIABILITY PROGRAM providing precision miniature electric motors to specified levels for critical applications is described in 6-page booklet.—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 282 ON READER-SERVICE CARD

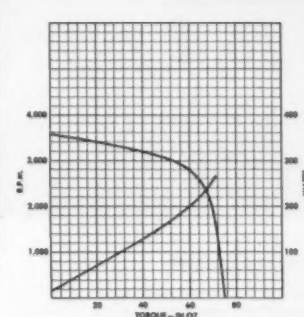
TIME DELAY RELAYS and SCR Magnetic Modulators are described in 4-page brochure.—Voi-Shan Electronics, Dept. ETM 13259 Sherman Way, North Hollywood, Calif.

CIRCLE 283 ON READER-SERVICE CARD



NEW

The
"G FRAME"
series



Typical curve on a
"G FRAME" series
2 pole 3 ϕ motor

SPECIFICATIONS:

Dia.: 3 1/2" (plain)
3" (finned)

H.P.: 1/400 to 1/4

Freq.: 60 cps

Phase: 1 ϕ or 3 ϕ

Poles: 2 or 4

Ambient Temp.:
-55°C to +125°C

Designed to military and industrial specifications the new "G FRAME" series motors are another addition to the wide line of AIR MARINE motors, blowers and fans.

A symbol of quality products... This trademark identifies the Air Marine line of carefully engineered products designed for military and industrial applications.

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CIRCLE 96 ON READER-SERVICE CARD

POWER SUPPLIES, static-regulated dc from 5 amp, 6-v to 1500-amp, 28-29 v, are detailed in 8-page brochure.—Rapid Electric Co., Inc., 2881 Middle-town Rd., Bronx 61, N. Y.

CIRCLE 284 ON READER-SERVICE CARD

LEADS AND TERMINALS for high-altitude, high-voltage power transmission requirements are detailed in 6 page folder.—AMP Inc., Harrisburg, Pa.

CIRCLE 285 ON READER-SERVICE CARD

CERAMIC PLANAR TRIODES (Models GL-6442 and GL-6771) information is presented for application of the tubes as amplifiers, oscillators and multipliers. Examples of typical circuits are included in 32-page Bulletin PT-46.—General Electric Power Tube Dept., Schenectady 5, N. Y.

CIRCLE 286 ON READER-SERVICE CARD

DC-COUPLED DECADE AMPLIFIER, Model 201-B, which is compact, stable, and wide-range with controlled voltage gain of 10, is described in 2-page bulletin.—Quan-Tech Laboratories, Inc., 60 Parsippany Blvd., Boonton, N. J.

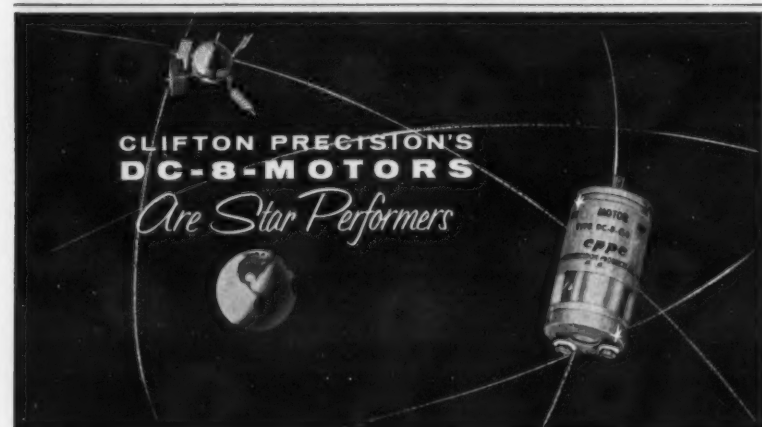
CIRCLE 287 ON READER-SERVICE CARD

ELECTRON TUBES of all types are described in tabulated form in 25-page Catalog CC860.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

CIRCLE 288 ON READER-SERVICE CARD

TERMINAL BOARDS, 8-page Bulletin 61-3 includes electrical and mechanical specs, dimensional drawings, and selection table of military terminal boards.—Kulka Electric Corp., 633-643 S. Fulton Ave., Mt. Vernon, N. Y.

CIRCLE 289 ON READER-SERVICE CARD



500 HOUR LIFE GUARANTEE*

Due largely to improved brush design, CPCC size 8 DC motors qualify to catalogue specification after 500 + hours of continuous duty or 200,000 cycles of intermittent duty in controlled environments.

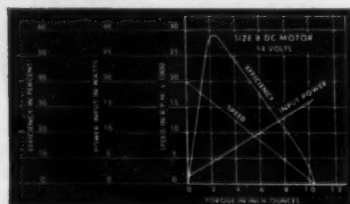
PRECISION CONSTRUCTION

Featuring a 12-bar commutator (5/16" dia.), stainless steel ball bearings, and corrosion resistant materials, the DC-8 family of motors is designed for miniature instrument systems. Weight 40 gms., length 1.380" max., dia., .750".

OUTSTANDING EFFICIENCY

The typical performance curves (below) exhibit a linear torque-speed characteristic. The efficiency—up to 60% at .25 in. oz. torque—considerably surpasses that of other types of Servomotors.

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CLIFTON HEIGHTS, PA.
ENGINEERS—Join a pioneer in the rotary components field. Write David D. Brown, Director of Personnel.

CIRCLE 97 ON READER-SERVICE CARD

MICROWAVE SYSTEM, 8-page bulletin describes RT-3A Heterodyne TV Repeater for unattended TV and communications relaying in the 2-kmc frequency range.—Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N. Y.

CIRCLE 290 ON READER-SERVICE CARD

PRECISION POTENTIOMETERS, Six 2-page data sheets describe wire-wound multi and single-turn potentiometers and applications.—Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles 22, Calif.

CIRCLE 291 ON READER-SERVICE CARD

INCREMENTAL DIGITAL ENCODERS based on Optisyn design for digital servos, numerical control systems, integrating accelerometers and inertial platforms are described in Data Sheets 604-606.—Dynamics Research Corp., 38 Montvale Ave., Stoneham, Mass.

CIRCLE 292 ON READER-SERVICE CARD

AUTOMATIC CHECKOUT of electronic equipment at flight line, factory quality control levels, etc. is discussed in 8-page Brochure 2549M2, "GEPAC, General Electric Programmable Automatic Comparator."—Armament and Control Section, Light Military Electronics Dept., General Electric, 600 Main St., Johnson City, N. J.

CIRCLE 293 ON READER-SERVICE CARD

BLOWERS, FANS, VANEAXIALS are described in 8-page condensed catalog.—IMC Magnetics Corp., 570 Main St., Westbury, L. I., N. Y.

CIRCLE 294 ON READER-SERVICE CARD

MILLIMETER-WAVE ferrite devices and microwave components in the 26 to 140 kmc frequency are detailed and tabulated in 4-page Catalog 260A.—TRG, Inc., 9 Union Sq., Somerville, Mass.

CIRCLE 295 ON READER-SERVICE CARD

SERVO AMPLIFIERS (solid state types) for military and industrial applications are detailed in 16-page Catalog S-1169.—Magnetic Amplifiers Div., Siegler Corp., 632 Tinton Ave., New York 55, N. Y.

CIRCLE 296 ON READER-SERVICE CARD

SILICON STABISTORS, Types STC 135 and STC 235, for use in transistor bias circuits, low level clipping, or in reference and regulator service are described in 2-page Bulletin 11-133.—Silicon Transistor Corp., Carle Place, Long Island, N. Y.

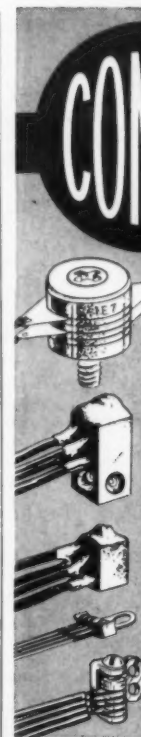
CIRCLE 297 ON READER-SERVICE CARD

POWER SUPPLIES—9 wide-range transistorized and 5 transient suppressed, high-current, magnetically regulated dc types—are detailed in 12-page catalog.—Armour Stabivolt Div., Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif.

CIRCLE 298 ON READER-SERVICE CARD

PRESSURE SWITCH, adjustable miniature Type C2060 for switching circuits in response to pressure changes in gases and liquids, is described in 2-page Bulletin AV2015.—Bristol Co., Aircraft Equipment Div., Waterbury 20, Conn.

CIRCLE 299 ON READER-SERVICE CARD



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COPPER OXIDE
AND SELENIUM**

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RING MODULATORS
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SELENIUM CELL SIZES FROM .080" round TO 2" SQUARE. .020" TO .045" THICK.

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These quantities and many others may be accurately and instantaneously (20 μ s) determined by use of the Bently distance detector.

The Bently distance detector is a precision electro-mechanical transducer. It generates a directly following (D.C.) voltage as a function of distance between its sensor head and any electrically conducting surface. Available sensitivities allow measurements from micro inches thru tenths of an inch.

D-151 standard distance detector
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Sensor heads for detection
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CIRCLE 101 ON READER-SERVICE CARD

January-February, 1961

MESA TRANSISTOR (2N741) used as a power oscillator and class C amplifier is described in 4-page Application Note AN 124.—Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Arizona.

CIRCLE 300 ON READER-SERVICE CARD

MONITOR ALARM. 4-page brochure describes Signal Sentry monitor alarm system accurate to 0.1% for 30 stations, portable, self-checking, 6-months maintenance-free operation.—Communications Control Corp., 14707 Keswick St., Van Nuys, Calif.

CIRCLE 301 ON READER-SERVICE CARD

MIDGET CHOPPER. 2-page Spec 266 details characteristics and ratings for Model 30 chopper (21/64" x 21/32" x 5/8", 9 gm).—Airpax Electronics Inc., Cambridge Div., Cambridge, Md.

CIRCLE 302 ON READER-SERVICE CARD

VOLTAGE DIGITIZERS. 4-page data sheets describe Model V12-AD, 3-decimal digit unit, and Model VR12-AB, 12-binary-bit unit.—Adage, Inc., 292 Main St., Cambridge 42, Mass.

CIRCLE 303 ON READER-SERVICE CARD

WAVEGUIDE ROTARY JOINTS—I, L, and U stock design styles—are detailed and illustrated in 4-page Catalog RJ-60.—Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.

CIRCLE 304 ON READER-SERVICE CARD

CAPACITORS. 4-page Bulletin GEA-6819B describes Computer-Grade Aluminized capacitors (using 99.99% pure aluminum foil) for power supply in computers.—General Electric, Schenectady 5, N. Y.

CIRCLE 305 ON READER-SERVICE CARD

CONTROL CHASSIS. Model K-111A, for acquisition, storage and translation of digital data is described in 2-page Bulletin DPS/A5.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 306 ON READER-SERVICE CARD

POWER SUPPLIES (regulated)—convection cooled, tube, transistor, rack and portable types—are included in descriptive 8-page catalog.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.

CIRCLE 307 ON READER-SERVICE CARD

MOLDED COMPONENTS—insulated and metal caps, glass to metal seals, diode dip boards, etc.—are described and illustrated in 6-page Bulletin 3-58.—Warren Components Div., Eltronics, Inc., Warren, Pa.

CIRCLE 308 ON READER-SERVICE CARD

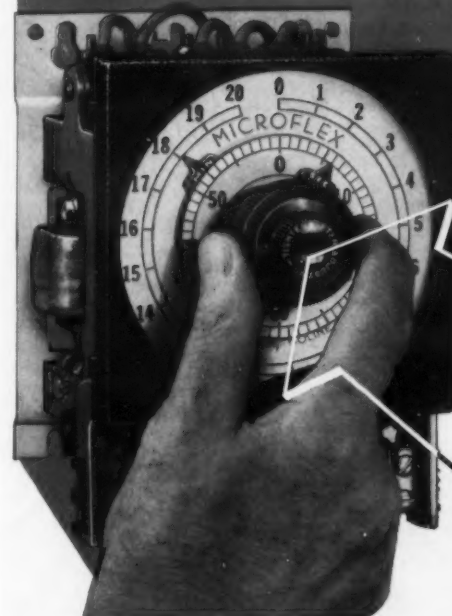
SILICON RECTIFIERS. Series C through E, and Vari-Stack (unit package of 4 diodes) are described in 16-page short form catalog.—Standard Rectifier Corp., 620 E. Dyer Rd., Santa Ana, Calif.

CIRCLE 309 ON READER-SERVICE CARD

Precision in timing Accuracy in setting

for

GROUND SUPPORT EQUIPMENT

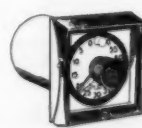


20 TURN MICROMETER DIAL

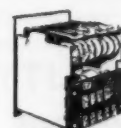
The EAGLE Microflex Timer provides unequalled accuracy in closing or opening a circuit. An easy-to-read 20 turn double micrometer dial speeds the selection of new settings over full 7200° range and permits a one-glance check of previously set intervals.

- **PIN-POINT ACCURACY** is possible with 1200 conveniently spaced dial markings. No guessing at in-between points. Accuracy maintained by patented pinion and threaded axle.
- **9 DIFFERENT ACTIONS** are available for each of 3 SPST 15 ampere contacts which can be selected according to circuit requirements.
- **PLUG-IN COMPONENTS** allow rapid replacement of timers. Large capacity contacts eliminate additional load relays.

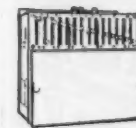
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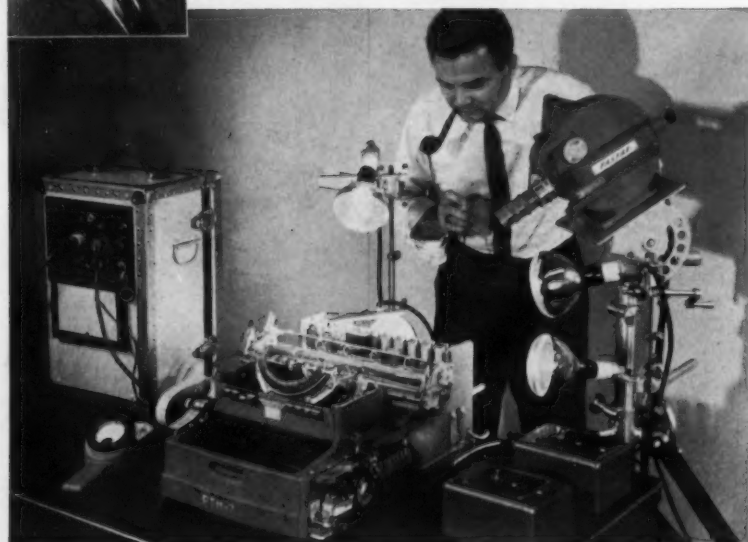
MANUFACTURERS OF THE MOST COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS

CIRCLE 102 ON READER-SERVICE CARD



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"Compared to the time and money FASTAX has saved our Company the cost of this precision camera was negligible."

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CIRCLE 103 ON READER-SERVICE CARD



CIRCLE 104 ON READER-SERVICE CARD

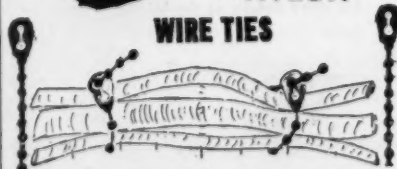
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CIRCLE 105 ON READER-SERVICE CARD

SWEEP GENERATORS, Marker Equipment, RF Attenuators, Detectors, and Filters are detailed in set of 26 technical bulletins.—Telonic Industries, Inc., Beech Grove, Ind.

CIRCLE 311 ON READER-SERVICE CARD

SILICON DIODES. Three 2-page bulletins detail medium power silicon diodes—diffused junction, double anode (twin zener), and diffused junction zener types. Also, three 2-page bulletins give specs of "Sildisc" diodes for standard miniature light bulb sockets and for blocking in d-c circuits.—Controls Company of America, Electron Div., Tempe, Arizona.

CIRCLE 312 ON READER-SERVICE CARD

SERVO DEVELOPMENT KIT. Size A, which contains assortment of 116 parts for assembling variety of servo mechanisms, is described in 2-page Bulletin 105.—Precision Mechanisms Corp., 577 Newbridge Ave., E. Meadow, L. I., N. Y.

CIRCLE 313 ON READER-SERVICE CARD

RESISTORS. 12-page Bulletin 7350 gives information on standard resistors of regular winding, non-inductive winding, and super non-inductive winding designs.—Sprague Electric Co., North Adams, Mass.

CIRCLE 314 ON READER-SERVICE CARD

ATTENUATORS—Mil-spec, precision gage, level set, variable cutoff types—are described in 4-page Bulletin 500.—PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y.

CIRCLE 315 ON READER-SERVICE CARD

SILICON RECTIFIERS in 1N Series—Type 6B (20 amp), Type 4B (35 amp) and Type 8B (70 amp)—are described in three bulletins. Also, silicon rectifier stack assemblies are described in Bulletin 6.315.—Fansteel Metallurgical Corp., Rectifier-Capacitor Div., North Chicago, Ill.

CIRCLE 316 ON READER-SERVICE CARD

SOLENOIDS, Series DS, for automatic equipment requiring a moderate power source are described in 2-page Bulletin 101.—Artisan Electronics Corp., 171 Ridgedale Ave., Morristown, N. J.

CIRCLE 317 ON READER-SERVICE CARD

RESISTORS. 2-page Data Sheet 178 details Series 170 42-turn square trimmer resistor; 2-page Data Sheet 177 details Series 180 25-turn rectangular trimmer resistor, both made with hi temp metal-ceramic element for military, computer and similar applications.—CTS Corp., Elkhart, Ind.

CIRCLE 318 ON READER-SERVICE CARD

SELF-MANIFOLDING VALVE, 12-page brochure presents MV-74MM Building Block valve featuring balanced poppet and symmetrical body design for single or multiple valve application.—Marotta Valve Corp., Boonton Ave., Boonton, N. J.

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MICROWAVE OSCILLATORS. 4-page Bulletin 814-A features Series 814 ultra-stable tunable units that "span the microwave spectrum."—Laboratory for Electronics, Inc., Instrument Div., Boston 15, Mass.

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CIRCLE 106 ON READER-SERVICE CARD

Special Editorial Emphasis on Logic Elements & Micro Relays

will highlight the March-April issue of **MILITARY SYSTEMS DESIGN**.

ADVERTISERS are also reminded that March-April will be the first 1961 Fosdick "Ad Readership Study" issue.

CONTACT ANY MSD REP—see inside front cover for addresses. Your ad copy and cuts accepted to April 1.

MILITARY SYSTEMS DESIGN

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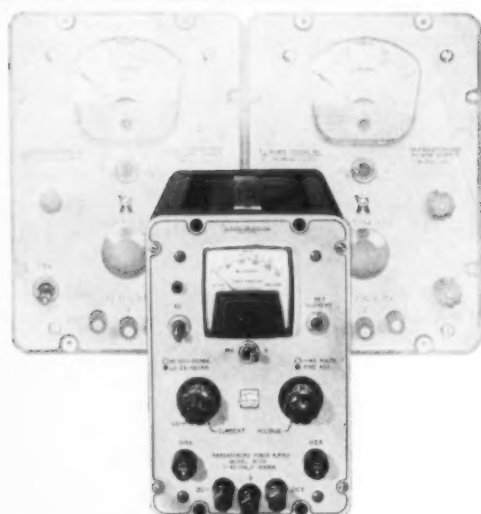
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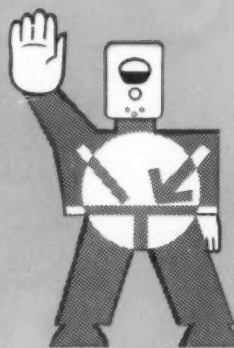
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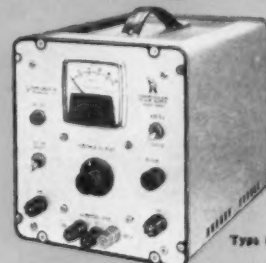
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MARCH 9-10—Symposium of Engineering Aspects of Magnetohydrodynamics, Univ. of Pennsylvania, Philadelphia, Pa. Sponsored by PGNS, AIEE & IAS. Write J. L. Dunlap, Oak Ridge Natl. Lab., P. O. Box Y, Oak Ridge, Tenn.

MARCH 20-23—IRE International Convention, Coliseum & Waldorf-Astoria Hotel, New York, N. Y. Write E. G. Gannett, IRE Headquarters, 1 East 79th St., New York 21, N. Y.

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